FACTORY ADMINISTRATION IN PRACTICE

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ORGANIZATION AND ADMINISTRATION FROM THE FACTORY STANDPOINT

BY

W. J. HISCOX

AND

JAMES STIRLING, A.M.I.Mech.E.

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PREFACE
TO SIXTH EDITION

In the various editions that have been necessary since the publication of the first edition of this book, opportunity has been taken to make minor revisions in the text in the light of the developments of modern practice, as well as to increase the scope of the work. This latter has been done by reason of the fact that many educational institutions throughout the country have adopted the book as a textbook for classes in factory administration and organization, while the Council of the Institute of Cost and Works Accountants have recommended it to those preparing for the professional examinations of that Institute. This increased use of a practical rather than a theoretical book is evidence of the desire of these authorities for the more practical training of entrants into industrial careers. This tendency, therefore, led to the inclusion in the second and subsequent editions of additional matter on factory buildings, plant, and materials, the organization and administration of labour within the factory, and other matters, that the syllabus of these examinations might be more completely covered, and that the reader might obtain an outline of those aspects of factory administration, an understanding of which is indispensable to the business executive.

It is indeed a tribute to the late Mr. W. J. Hiscox that his original work, on a subject on which so many ideas have been expressed, should still enjoy such appreciation as the demand implies.

In the fifth edition the present writer was privileged to revise the basic work and to enlarge on Part II, which Mr. John R. Price had contributed for the fourth edition. Further revision, clarification, and additions have been made for this the sixth edition.

Thanks are due to correspondents who have drawn attention to occasional ambiguities which it is hoped have now been cleared. Particular thanks are due to Mr. S. N. Panigrahi, B.A., B.Com., whose kindly but painstaking criticism of detail in correspondence from India has led to an improvement which must make easier the study of this work.

J. S.

PREFACE

TO FIRST EDITION

THE publication of a book on Factory Administration is a by no means unique event, for there are at the present time many excellent volumes in existence, and it is not with the idea of challenging these that this book is presented. Each existing work, whether it be a general treatise or a reference book, has its own place in the industrial world, and it is the ambition of the author to be considered worthy to be named with those who have already contributed their quota to industrial literature.

One point, however, which may commend itself to the reader is that this book has been written from the factory standpoint, from which it may be inferred that the difficulties and troubles encountered in the shops are appreciated and sympathetically referred to. In short, the book is written to appeal to the factory man, the works manager, the department foreman, and each and every active member of the factory administrative staff. The views expressed—the schemes outlined—are the results of sixteen years' practical experience, gained through the author's association with well-known engineering firms, and administration from the factory standpoint is a subject which merits consideration.

Another point which will not fail to attract notice is that the progress system is for probably the first time brought into prominence. Some of the more recent writers have recognized the progress department as a unit of factory administration, and articles on the subject have appeared from time to time in the technical journals, and have given rise to animated discussion. The views of the author in this direction are, however, somewhat far reaching, for he is convinced that the progress system, thoroughly understood, is capable of raising factory administration to the highest degree of efficiency.

W. J. H.

INTRODUCTION

EXPERIENCE has brought to light one or two matters which, although their treatment would occasion no difficulty to factory men reading this useful book by Mr. W. J. Hiscox, are yet in need of amplification when the book is considered as a tutorial medium. In order to ensure that the book will fulfil the functions of textbook to those students who are preparing for professional examinations in the subjects of factory administration, organization and management, it has been found necessary to revise some of the sections. The changes made are the outcome of considerable experience of the difficulties encountered by students using the book. It is believed that this revision will be appreciated in the now numerous educational institutions where the work is prescribed as class textbook. It has been thought well to give below a rather full consideration of the various meanings of "administration."

Administration

THE term "administration" as used in Part I by the late Mr. Hiscox denotes the functions controlled by the Progress Manager. There can be no doubt that this is the intended meaning. It is made very clear in the last two paragraphs of page 12; it is illustrated in Fig. 1; and is implied in repeated statements and usages throughout the whole of Part I. A very different meaning is assigned to the use of the word by Mr. Price in Part II. In the first paragraph of page 277 administration is defined as "the work of determining the policy of the business and of co-ordinating the sales, distribution and finance aspects of the business with the production through the system of organization which is set up." Thus Mr. Hiscox used the term as a function of the management, whereas Mr. Price uses the term as a function of the directorate. Both uses of the word are correct, of course. In the dictionary sense to administer is to direct. Part I uses the term to cover the direction functions of management in the factory shops; Part II uses the term to cover the direction functions in the Board Room. As is so often the case, however, a specific sense is assumed in the professional use of this general word.

Among the authors contemporary with Mr. Hiscox there was no consistent use of the term, but to-day there is general agreement that the term covers the functions of the higher control of a business. Actually there is still some diversity of opinion as to the scope of its operation. Some authorities use the term in a generic sense covering not only the determination of policy but also the entire range of management down to routine supervision. Others restrict its scope to the functions controlled by the directors of the business. It is true that the responsibilities of administration and management merge in a gradual fashion which makes the fixing of boundaries difficult. Nevertheless, a difference exists and demarcation of duties in a general sense is both possible and advisable. The definition in Part II, page 277, first paragraph, should be accepted as accredited modern usage of the term. Part I really deals with the executive responsibilities of management; Part II introduces the determinative, directive and co-ordinative responsibilities of administration.

To the factory man these differences of definition are of little consequence; to him the context disallows of misunderstanding. To the student preparing for a professional examination the difference of interpretation is very important; as is evident from a consideration of the Institute of Cost and Works Accountants final examination question 23 reproduced on page 292. In this question an exact understanding of the difference between the terms "administration" and "management" is demanded.

As implied above, the office of administration is tripartite, the individual aspects being (*a*) determinative, (*b*) directive, and (*c*) co-ordinative. Each of these aspects will be discussed later. The office is held by the directors of the business. The constitution of the Board of Directors varies in practice. In some cases the Managing Director is the sole representative of the board in the factory. In other instances the head of each of the main factory divisions may have his place on the board. It must be borne in mind, however, that the duties of the directorate are administrative rather than managerial. This difference is distinct and of primary importance, and where one person is made responsible for both administrative and managerial duties care must be exercised, firstly, that such a director can satisfactorily fulfil the whole obligations of both offices, and secondly, that the Board of Directors

is so constituted that due weight is assured for countering any unbalance that such a director may show in favour of particular divisions. Moreover, it will be realized that the functions of administration and management require different qualities. A good manager may be a very poor administrator. The one is the complement of the other; it is the duty of the management to carry out the administrative policy of the directors.

(*a*) The Determinative Aspect of Administration

The determinative function of the administration of a business demands continuous and painstaking study of all the factors which govern the successful working of the enterprise. It calls for the formulation of policy in respect of finance, experiment, organization, labour, production, sales, and advertising. Without such policies laid before them the management is unaware of the precise aims or objectives of the directors; chaos is inevitable. Policy may be defined as the course of action determined by the directors of a business for the guidance of the management. It provides the management with a defined objective and a definite plan for reaching it. The importance of this aspect cannot be over-emphasized. It is to the directors that the shareholders must look for a fair return on their capital.

(*b*) The Directive Aspect of Administration

A clearly defined policy for every project of the business having been determined, it is then necessary for the directors to guide the management in the accomplishment of its task. Firstly, the organization must be shaped to suit the requirements of the policy laid down. Organization is the systematic separation and co-ordination of functions. It is the careful allocation of the duties and responsibilities of the various individuals involved in the production according to their respective abilities, and the co-ordination of their efforts so that the objectives of the business are obtained in the most efficient manner. Wise administration takes note of the weaknesses that develop in the established organization as policy changes or progresses. It aims at having an organization that is adaptable to changing conditions, that is as nearly self-working as is possible and that justifies its expense. The three main forms of factory organization are discussed in Chapter XXXIV. Secondly, the

management of the business must be conducted on systematic and scientific lines. Executives must be free of all detail routine work so that the major problems of production can have their full attention. This state is accomplished by the introduction and maintenance of system throughout the entire organization. System is the established method set up by the management of a factory for the performance of recurring duties in regular fashion. The administration must ensure that these managerial functions are discharged in a competent manner. The prevailing management methods should be compared with the best known methods practised in other successful concerns.

It should be noted that organization and management are interrelated. Organization is the structure or form of a business, the form being designed to effect the necessary co-ordination of the separate functions. Management is the controlling influence on organization; it directs the operation of the several parts of the organization, ensuring its smooth and efficient working. The organization of a factory is a complex machine which requires expert superintendence continually, and this superintendence is the responsibility of the management.

(*c*) The Co-ordinative Aspect of Administration

An important function of the administration of a business is the co-ordination of its various divisions. Unity of purpose must exist. It would be extreme folly to allow the designing and the production divisions to proceed individually without the guidance of a co-ordinating policy, or to let manufacture run irrespective of the failure of the sales force. Administration must maintain equilibrium between divisions. The organization is framed to effect this as far as is possible, and management ensures unity of purpose within each division. But it is the responsibility of the administration to co-ordinate the efforts of the divisions.

J. S.

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FACTORY ADMINISTRATION IN PRACTICE

PART I

CHAPTER I

ADMINISTRATION AND REORGANIZATION

THE administrative side of factory management is slowly but surely coming to its own, for it is now recognized that, without efficient administration, the productive capacity of the factory cannot be extended. The factory manager to-day is on his mettle—he is being judged by results, and he is shrewd enough to appreciate that management is not a one-man job. He knows that if he attempts to grapple with the problem single-handed he will meet with defeat, and recognizes that, for success to be achieved, he must invite the co-operation of others.

In other words, the works manager to-day is the chairman of a board of management, and this board consists of those who, no matter what position in the factory they occupy, are using their brains. Each is an expert in one specific phase of management or industry, in connection with which his opinions are treated with respect; and it is the works manager's business, not to ignore these people and work as hard as possible himself, but to guide and control, giving each person ample scope for his activities, and putting to practical uses the whole of the sagacity and the ingenuity he can call forth.

The autocratic works manager has gone—never to return. No longer do we shrink from a summons to that dreaded compartment wherein the autocrat was seated. No longer do we meekly listen to his commands, and do exactly as we are told, irrespective of whether it be right or wrong. After all, *he* was running the factory, and upon his shoulders was the whole of the responsibility, so why should *we* worry? *He* got the credit, and could afford to be enthusiastic, but why should we be called upon to exhibit enthusiasm?

But to-day this has changed. All have responsibilities, as well as the works manager. He is our chief, and him we obey, but we do not obey blindly. The new spirit is upon us. We have intelligence, and we know it. We have experience, and we use it. About our own little job we know more than does the works manager, but we do not parade the fact. We recognize that it is by merit that he has attained his present position, and we respect him for it. He is managing the factory, with our assistance. We are managing our own department, with the assistance of our subordinates.

Having responsibilities, we are enthusiastic, and we take a personal interest in the business. Just as the works manager is proud of the progress made by the factory as a whole, so also are we proud of the progress made by our department—or our section. No matter how humble our position may be, we evince a lively interest in all appertaining thereto, and take a personal pride in that for which we are responsible.

Responsibility begets enthusiasm, and enthusiasm is the soul of progress. We know that our opinions carry weight, and we do not hesitate to express them. So the best that is in us is for ever making its presence felt, which is of equal advantage to ourselves, to the factory, and to industry generally.

Enthusiasm is essential to the well-being and success of administration, for at the present time it is no light task that we have set ourselves. We have to rebuild industry, and no possibility, however remote, can afford to be ignored. With the high taxation and increased cost of living we have been brought to realize that it is only by united effort, by the elimination of all wasted energy, that we can win back what we have lost, and in saving our industry effect our own salvation.

Reorganization

Can it be wondered at, therefore, that our factories are being reorganized—that the theoretical organizations of the past are being discarded in favour of something more in keeping with the times—and that the services of the practical man are being utilized? Is it not recognized that practical experience cannot be ignored, and that, before administration can become efficient, a drastic reorganization of the factory is a necessity?

Reorganization implies far more than superficial alteration,

either to the system or to the plant, and it must be carried out in accordance with the needs of the factory, for whilst the fundamental principle is common to the whole industry, the methods of application vary in accordance with the peculiarities of the specific line of manufacture. It by no means follows that, because a certain method proves successful in one factory, the same measure of success must of necessity follow its application to another factory, and the works manager or organizer, going from a well organized factory to a badly organized one, invariably meets with failure should he endeavour to force upon the latter factory the system which has proved so successful elsewhere.

The first essential, therefore, is to know why reorganization is necessary, the second to know precisely the methods by which it can be effected. This means a system of education, which must be applied, not to any one section only, but to the entire factory. It is not enough for the organizer to be thoroughly conversant with the whys and wherefores, for how can any one man be expected to carry out a reorganization scheme unaided, or of what value to him is the assistance of others who do not understand either the reasons demanding or the methods employed in effecting the change? The organizer must first educate himself, and then enter upon the task of educating those upon whose co-operation and assistance he must depend—the management, the staff and the workers.

It is not generally realized that failure to ensure an efficient organization is in many cases directly attributable to the non-education of the factory workers. The factory organization, as a matter of fact, affects them quite as much as it does the management, and yet they are expected to conform to rules and regulations, and work in accordance with a mode of procedure, the meaning of which is never explained to them, the consequence being that the significance of the proceeding is entirely missed. Far better is it for the management to take the workers into its confidence, to apprise them of any impending change, and to advise them of the circumstances which make it necessary. Explanations of any knotty point should never be avoided, and all inquiries should be answered courteously. To obtain the goodwill of the workers this procedure is essential, and without that goodwill and co-operation no scheme of reorganization will effect the result desired.

The education of the staff officials is also an important matter, and to illustrate the necessity for this it will perhaps be well, at this juncture, to consider the best means of carrying into effect an efficient and comprehensive reorganization scheme. Much depends upon this, for patch-work, involving a vast amount of energy, but resulting in a very small amount of efficiency, cannot in any circumstances be termed reorganization.

The reorganization of the factory should be in the hands of one man, and he an experienced organizer—a new-comer for preference, and not necessarily a works manager. It may, indeed, be better that the works manager does not take to himself the actual task of reorganizing, particularly if he has been with the firm for a long period. It may be assumed, therefore, that the manager, recognizing the pressing need for reorganization, does not attempt to cope with the problem unaided, but engages a man whose past experience and record eminently fit him for the task to be taken in hand. This man is a professional—an expert—and although he may know little or nothing of the specific line of business which engages the attention of the firm, his knowledge of the methods employed in industry as a whole—the fact that he has concentrated wholly and solely upon the science of organization—enables him to formulate his plan of campaign as soon as he has become conversant with the existing system, and the peculiarities of the line of manufacture for which it caters.

The Organizer

Having educated himself, the organizer must educate the manager, by showing him the defects of the existing system, and how he proposes they should be remedied. The average manager requires a deal of convincing, especially when the organizer ruthlessly condemns methods which up to that time had been regarded as a sort of fetish by the manager. The organizer will need all his tact, for it is quite certain that many managers cling obstinately to the belief that obsolete methods can be made to fit in with modern conditions. Nothing really is farther from the truth, but the organizer will be called upon to demonstrate, not only the impracticability of such a proceeding, but also the practicability of his own ideas. Not until he has educated the manager in this direction can he hope to move with any measure of success, but once this obstacle has

been surmounted, he has gained an ally who will prove a valuable acquisition.

The organizer's next task is to educate the staff officials, and again hostility must be expected. From the moment he enters the factory he is an object of suspicion and distrust, especially to those who are heads of departments likely to be affected by the impending changes. This hostility is not always open, but it is there nevertheless, and it is not long before it becomes apparent to the organizer. A good deal of it is based upon misapprehension, and it is to remove this that the organizer must extend himself to educate those who are so afflicted.

The departmental heads, usually old servants of the company, are well versed in the rules and regulations of the factory, and the practices prevailing. They understand every detail used in manufacture, and do not have to refer to a drawing in order to identify any specific part. Consequently they have the advantage of the new-comer, and failure to obtain their whole-hearted co-operation adds greatly to the difficulties and the perplexities of the man responsible for the reorganization of the factory.

The organizer does not expect to be popular, for what reformer is? He must, in a tactful manner, tell people they have done what they should not, and left undone the things they should have done, and he must then demonstrate precisely what he means. A new routine system is proposed, new methods of production advocated, and it may be new administrative departments created. A rearrangement is necessary in the drawing office, department heads are relieved of certain duties, and other duties given in exchange. Men are taken from one department and put into another, and individual activity is condensed. All this conduces to antagonism on the part of the older officials, unless they are properly educated so that they can appreciate the significance of the change.

As obsolete methods must be thrown on the scrap heap, so must anything which may be clinging to them, and if an official, in spite of warnings, will persist in clinging to his old fetish, then he must go out with it. It has been stated earlier in this chapter that the educated manager will prove a valuable ally, and it is here that his value becomes apparent. The reactionaries of the factory will usually sit upon the fence, until the attitude of the management towards the new regime is discovered, and, if it is found that this

attitude involves a backing for the organizer, it is likely that their own education will make rapid strides. If, on the other hand, the organizer is left to fight unaided, then that fight must indeed be a bitter one, and the success of the scheme will not materialize quickly.

In an unorganized factory progress is maintained by individual effort, and it so happens that one individual has, by long years of service, acquired information relating to certain matters which is not known to anyone else in the factory. This individual is usually the most troublesome in the eyes of the organizer, for whilst he holds that information exclusively he considers himself an indispensable, and adopts an attitude in accordance with this belief. In such circumstances he *is* valuable, and is so recognized by the works manager; and a difficult task confronts the organizer when he essays to get this information upon the permanent records.

The manager, no doubt, has a sincere regard for an old servant, but he recognizes that friendship must not stand in the way of efficient development, and is prepared to act accordingly. But he pauses! This old servant is in possession of information, the loss of which would entail much inconvenience and expense. "This man is indispensable to us," he cries to the organizer. "You must make him fit in somewhere, even though it involves drastic modifications to your scheme, for should we allow him to go our output most certainly will suffer."

"And suppose he dies to-night?" queries the organizer, and the manager looks aghast. This supposition has never entered his mind. Old Williams had been with the firm for twenty years, and was quite an institution. Never absent, never late! Never had a day's illness! "But he *may* have," suggests the organizer, and the manager is forced to agree. An interview with the old servant follows, and the organizer either gets the information recorded as he desires, or the firm loses the valuable information sooner than anticipated, by the departure of the old servant.

Reorganization then implies drastic measures, and it is well, therefore, that the works manager recognizes this before committing himself. When once the boats are burnt there is no return, and subsequent hedging will do more harm than good. That is why the fear is expressed that a great many managers do not appreciate what reorganization implies, and as a result often commit themselves

more deeply than they had intended. Too late they realize the desperate position they are in, and then they must either go on or get out.

Finance

The financial side of the question must not be overlooked, for reorganization obviously implies additional expenditure in its initial stage. Far-reaching measures such as are entailed must necessarily mean increased costs, and this fact must be borne in mind by the directors. This additional initial expense must, however, be commensurate with the estimated benefits to be derived from the operation of the scheme, in the form not only of increased output but of increased profits.

Reorganization should not be attempted unless it is *intended* to reorganize, otherwise nothing but confusion and chaos will ensue, and unnecessary expense be incurred. It must be remembered that the system prevailing has carried the factory for a large number of years, and that that system must not be superseded unless it can be proved that another system will be more advantageous. If this can be proved, then there must be no half measures; the thing must go through, no matter who or what stands in its way. Whenever a new manager comes to a factory, there is not a little apprehension regarding the course he will take, for, as a rule, the advent of the new manager is quickly followed by changes in the personnel. This, however, is not reorganization.

What Organization Means

By organization of a business is meant a careful allocation of the duties and responsibilities of the various individuals involved in the production according to their respective abilities, and the co-ordination of their efforts so that the objective of the business is obtained in the most efficient manner, i.e. as quickly as possible yet economically and without quality or quantity suffering. Having then planned the business on these lines, the organization must introduce schemes of supervision to ensure that the plans laid down are carried out, while encouraging the team spirit amongst the workers.

CHAPTER II

INTRODUCING THE PROGRESS SYSTEM

THE progress system of works organization, now being adopted in almost every class of engineering factory in the country, can be applied with equal success in the small factory interested in the manufacture of one product, or in the large electrical engineering factory concerned with the production of a hundred different lines of manufacture. Originating in America, it has been remodelled to suit the peculiarities of British manufactures to such an extent that now its American parentage can scarcely be traced, and it has come to be regarded as typically British.

The system is instituted to allow the business idea to operate in the factory, *to co-ordinate commercial sagacity with engineering ingenuity*, and in this respect it is eminently successful. In the days gone by the factory was the engineer's citadel, to which those not possessing mechanical qualifications were admitted only on sufferance. A gulf was fixed between the factory and the commercial departments, and business suffered as a consequence.

The engineer was concerned with construction, and commercial possibilities failed to excite his interests. The commercial man was *of* the factory, yet not *in* the factory, and he could not appreciate the engineer's standpoint. The one was there to produce; the other was there to sell, and yet the two interests, although dependent upon each other, were so far apart.

Far-seeing employers grasped the significance of this lack of co-ordination, and realized that if they were to compete successfully with home and foreign rivals, business would have to be let into the workshop. The progress system was employed to bridge the gulf, and it may be said, in passing, that the introduction of the progress system was the first step towards the application of scientific management to the factory organization.

Under the old order of things the mechanic was pre-eminent, and everything was subservient to him. A system was brought into being by the accountant, and left to the tender mercies of men who, viewing the factory from a different standpoint, could not be expected to appreciate the spirit. It was letter learned, and

carried out as far as possible. Clerks and other assistants, being necessary, were engaged by the mechanic, who could not teach them their duties. Can it be wondered that inefficiency was paramount? The factory was filled with officials—energetic but ineffective—and their cost was out of proportion to the value of services rendered.

They did as they were told, for they were controlled by the mechanic, and, generally speaking, the mechanic has very little aptitude for business, and does not realize that his product must not only be a work of art, but a saleable commodity besides. It is to give the mechanic every opportunity of producing a work of art *and* a saleable commodity that the business man *comes into the workshop* and proffers his services.

Apart from the fact that the mechanic did not understand the business part, his other work suffered on account of the time spent on administration and other clerical duties which could not be neglected, and one of the chief points in favour of the progress system is that it relieves the mechanic of all the duties he does not understand, thus enabling him to concentrate upon what he *does* understand. The progress system has been assailed in some quarters on the grounds that, far from relieving the mechanic, it really adds to his responsibility, but this is where the system is being played with, probably because it is not understood by the management.

The fact that a progress department is created is not evidence of the adoption of the system. The department is the outward and visible form, and is absolutely indispensable to the success of the system, but it is not *the system.* Much depends upon the status enjoyed by the department, for unless it is an unfettered and a "directing" department the system is not being correctly interpreted and cannot therefore be a success. The author's ideas of the real progress department are given in detail in a later chapter.

The adoption of the progress system means the recognition in the workshop of the business man—a man expert in the art of organization and administration—who is prepared to give the mechanic every facility to produce by ensuring that every effort is effective. In the first place he is told by those who know what *can* be done, and this he must see *is* done. He does not stop here, for his work is but half done. He must make the pace, and convince the mechanic that still more can be done. It is this latter part which is not generally appreciated.

Let us give a brief illustration. The planner, i.e. the man who knows, says that the factory can produce 250 assembled units per week. The factory at the moment is doing 170. The business man must devote his energies toward the realization of the planner's figure, and in so doing he is creating (1) the possibilities, and (2) the demand, for still more. It is more than possible that, in aiming at 250, he actually realizes 260, and from that he demonstrates to the mechanic, *and also the planner*, that still more is required and more must be produced.

This business man is the organizer described in the preceding chapter, and is known as the "Progress Manager." In the small and medium sized factory he is a person to be reckoned with, and is really indispensable. His activities are almost unlimited, for he is the power behind the throne. He is not merely the head of the Progress Department, for his influence is exercised throughout the entire factory. He exercises *direct* control over a definite side of the organization, but he exercises *indirect* control over the whole.

The aim of the progress system is to give due prominence to the commercial aspect, which in the past has not received the attention it merits. As a nation we are a very unbusinesslike people, and being so, are very wasteful. With the best inventors, the best engineers, and the best mechanics in the world we are gradually being ousted from our pre-eminent position, simply because we do not use commercial sagacity to exploit engineering ingenuity. The American, with less than half of our industrial advantages, exploits to the uttermost those which he has, and as a consequence he "gets there" with the goods whilst we are putting on the finishing touches.

What we make, we make to sell, and the more we sell, the more we can make. We must never be satisfied we are doing our best, or that we are doing the best "in the circumstances." That will do us no good. We must get out of those circumstances, and it is the duty of the business man inside the factory to point out the way. There is no question of the interference with the legitimate duties of others. The contention of the author is that administration is outside the scope of the foreman or engineer, and that, just as the engineer must qualify by experience for the position of foreman, experience in organization and business methods is the necessary qualification for the administrator.

The progress system brings administration to the fore, and provides an incentive for the engineer. The latter may, upon his own initiative, effect improvements, but the real significance of these is lost unless they are exploited as a commercial asset. One foreman may effect improvements in his own department, but he does not know how these will affect the factory as a whole. Far better is it for the whole factory to know what is expected of it, and then for everybody concerned to set out to reach the point.

The progress manager does not say how things shall be done, but he lets the factory know what must be done, and ensures administration being strong enough to cope with any demand made upon it. His requirements having been stated, plans for the fulfilment of these are drafted by the Planning Department, and then he must see that those plans are carried out in accordance with the ideas of the planner. That is to say, 250 sets are aimed at, and the Planning Department estimates that this demand can be met by certain methods and processes being adopted, and the responsibility is upon the progress manager to get the 250 sets by the methods set forth.

There are some who advocate the introduction of American efficiency methods into British factories, but, although we can undoubtedly learn much from these, it would be distinctly unwise to adopt them wholesale, without considering whether, notwithstanding their undoubted success over the water, they could be applied with equal success here. Industrial conditions in this country and in America are very dissimilar, and systems must be made to cater for manufacturing peculiarities. Even here, as previously stated, it is hardly possible to transfer a successful system, in its entirety, from one factory to another, and it behoves us therefore to tread warily before committing ourselves to any system, no matter how successful and efficient it may have been elsewhere.

It is wise to adapt certain ideas, if we shape them in accordance with our requirements, but it is wiser to use these adaptations as a line from which to spring. To illustrate what is meant it will be observed that in this book certain methods are given, with diagrams showing forms, etc., already in use. These represent the point reached by the author after many years of experience, and they are recommended because he has had definite proof of their worth. But it is not expected that the reader will swallow these wholesale,

say what fine ideas they are, and then straightway attempt to apply them to his own business. It is expected that the reader will criticize—will find fault—and then conceive an improvement. That is the idea with which this book is written, for a perusal of the other fellow's views will usually awaken a train of thought in the reader's mind which results not in the adoption of the view expressed, but in an improvement of that view.

The efficiency methods of America, therefore, are useful as a guide, whilst they teach us the lesson of the triumph of organization. What the Americans can do we, with our inherited advantages, undoubtedly can do, but only when we tackle the question seriously. For us, the progress system, thoroughly understood and intelligently applied, will do more than any other method, and it behoves us to take advantage of this, and exploit it to the uttermost.

The progress organization exercises direct control over the whole of the administration of the production departments in the factory, just as the Planning Department exercises control of the methods employed. In fact, the works manager has usually three assistants, each with independent status, who between them control production. They are the planning engineer or chief of planning, the progress manager, and the shop superintendent or head foreman. The planning engineer controls shop layout, operation planning, jig and tool design, tool room and tools, and rate fixing. He determines where and how each job shall be done and the time allowed to perform it. The progress manager controls the supply and issue of materials to production departments in accordance with the production programme and ensures that every operation is carried out in relation to the output plan. The head foreman controls the operatives—the actual producers, see Fig. 1.

The departments included in the factory administration as controlled by the progress manager are the Progress Department, Buying Department, Rough Material and Finished Parts Stores, Internal Transport, Packing and Despatch Departments. In certain works the Costing Department is also included in this category, but as a general rule this is inadvisable since manufacturing inefficiencies can be too readily hidden where costing is controlled by a production executive. Further, neither the works manager nor the progress manager is in a position to correlate costs with financial accounts, hence in most modern factories all costing is under the

control of the chief accountant, who is directly responsible to the managing director or general manager.

Sufficient has been written to introduce the progress system, its aim, and its object. The method of its application to the factory administration will be demonstrated in the succeeding pages, its influence upon each department being shown. It is not a destroyer of systems, but a builder up. It acts as a tonic, giving new life and vitality, strengthening the weak places, and ensuring for the factory

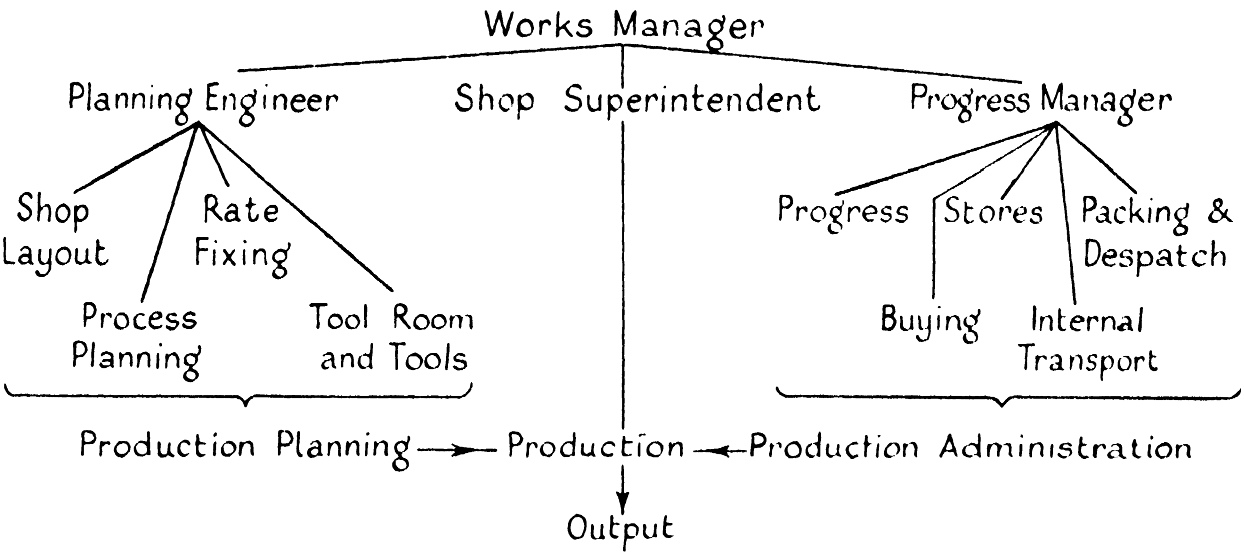


FIG. 1

a robust constitution. Health and strength are necessary for success, and this applies with equal force to the factory as to the individual.

As no system of production can ever be efficient unless it is properly carried out by the workmen, this introduction would not be complete without some word about the foreman, who is probably one of the most vital links in the chain of organization, since it is through him that the instructions are actually given to the men as he stands next in the line of control. He must be a man who can control his men and direct their endeavours without being too domineering, i.e. he must be a man of character who can inspire confidence and the team spirit in his workers. Besides directing their actual work his duties often include the allocation of work to individual men or machines, so that it is done in the best possible manner as well as keeping the shop running smoothly. When trouble arises in the nature of breakdowns, lack of materials, etc., he must be able to remedy the faults, or know how to obtain a remedy from those in charge so that delays in production can be reduced. The various reports and forms which will be described later are often compiled, or possibly countersigned, by the foreman.

CHAPTER III

THE COMMERCIAL (OR SALES) DEPARTMENT

As an order to the factory must emanate from a commercial department, i.e. a department outside the control of the actual factory organization, it is deemed advisable to consider this side before dealing with the factory proper; this despite the fact that the factory must, to a great extent, control the activities of the commercial man in the direction of new business. It will be explained later how this control is effected.

Much depends upon the class of manufacture handled by the concern, and it is proposed to take a few different types for the purpose of illustration. The mammoth concerns interested in one-hundred-and-one different types must of necessity have an elaborate organization, and the Commercial Department is not one, but many. There is the department which handles standard manufactures, and there is another interested in the semi-standard variety. Then there is the Foreign Department, this being concerned only with orders for export, whilst another department looks after heavy complete sets, such as the equipment of a central electric station, and still another is interested in specific industrial commitments, such as mining gear, and the like.

This then is a formidable undertaking to describe, but without entering into detail it is perhaps possible to give some indication how the orders emanate from these departments. Let it be said at once that a standard system operates, and that, by the time the orders reach the manufacturing departments, there is very little to identify them with any specific commercial department.

It is assumed that, in this factory, all goods are supplied (within limits) to the customer's specification, even the alleged standard lines being subject to some modification. That is to say, the variety of the firm's manufacture is so great that in practically every instance each customer's requirement can, to a great extent, be made to conform to a standard. To take the case of the electric motor, the customer requires a machine of certain capabilities under given conditions, and the firm's engineers determine the class

of motor suitable, and what specialities must be introduced. It may be that a certain size and type of motor, wound to a certain specification, will meet the case, or it may be that a special pulley, or an end shield, or some other modification is required.

Usually, the men in charge of these commercial departments are experienced engineers, and can determine very accurately the customer's requirements. This being so, the advance specifications can be prepared immediately upon receipt of an inquiry, these giving the size and type of the machine, together with what special features are required, and the estimated time necessary to prepare and issue the full specification. If the machine is a standard or semi-standard type, the commercial man is usually in possession of a delivery schedule, this being issued monthly from the Progress Office, and, if this is the case, the advance specification is sent to the Estimating Department. The costs and estimates being given, the specification is returned to the Commercial Department, and from the information gathered a quotation is submitted to the customer.

DELIVERY ESTIMATES FOR THE MONTH OF AUGUST, 19..

FOR TYPE X MOTOR

Size.	Standard.	Special Shaft.	Special Shields.	Special Punchings (Die exists).	Special Punchings (No die).
1	3 Weeks	4 Weeks	4 Weeks	5 Weeks	7 Weeks
2	3 ,,	4 ,,	4 ,,	5 ,,	7 ,,
3	4 ,,	4 ,,	4 ,,	5 ,,	7 ,,
4	5 ,,	6 ,,	6 ,,	6 ,,	8 ,,
5	6 ,,	7 ,,	7 ,,	8 ,,	10 ,,

FIG. 2

Where a number of special features are involved, it becomes necessary for the advance specification to be prepared rather fully, so as to give brief particulars of the specialities. For instance, a new frame may be necessary, this involving the making of special patterns before the actual manufacture can commence, or it may be that special windings necessitate new punched laminations, which in turn demand new dies. These facts must be given upon the advance specification for the information of both the Estimating Office and the Progress Office, otherwise an intelligent quotation obviously could not materialize.

In such a case, the advance specification is first sent to the Progress Office for the delivery estimate, and then passed on to the

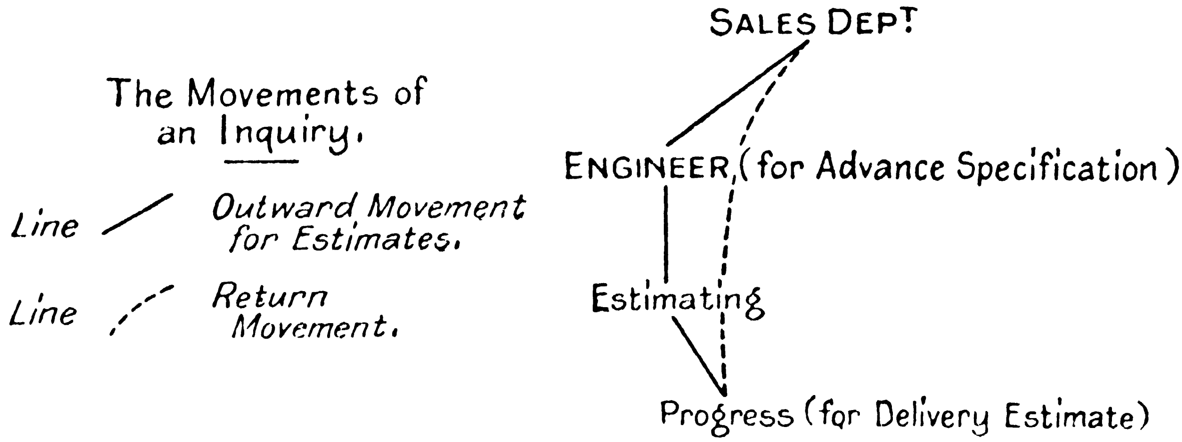


FIG. 3

Estimating Office. The information gained there forms the basis for the quotation.

ADVANCE SPECIFICATION IN CONNECTION WITH INQUIRY RECEIVED FOR

Quantity..................Name of Manufacture..

TO ESTIMATING DEPARTMENT Date..

FROM COMMERCIAL DEPT.

Type of Unit..

Size of Unit..

Specialities..

....

TO PROGRESS DEPARTMENT Date..

Please estimate DELIVERY and return to ESTIMATING DEPARTMENT.

Delivery Asked for..

Delivery Promised..

....

COSTING SUMMARY

....

FIG. 4

Quotations thus tendered usually stand good for thirty days, and should an order not materialize within that time, the estimates given automatically lapse. It will be appreciated that this is only fair to the estimator, whether for delivery or cost, for in the case of the former it is obvious that conditions in the factory play an important part, and must be taken into consideration by the Progress Office. To-day a certain type of machine may be quoted at three months delivery, but six weeks hence, owing to changed conditions, the quotation for a similar machine may be four months, or it may be reduced to ten weeks. In the case of the cost estimate, too, fluctuations or changes in the prices of material and labour necessitate periodical adjustments of estimates, and thirty days, therefore, may be considered a very generous allowance for the customer.

The quotation having materialized into an order, this now is under the control of the commercial man, who is the customer's representative, so far as the factory is concerned. The factory has agreed (through the estimators) to take on the job at a certain price and for a certain delivery, provided that the specifications are issued by the time specified, and no drastic changes are anticipated. The onus then is upon the commercial man to get out the specifications, and forward these to the Drawing Office, and when this has been done, he has the right to assume that the work will be executed in accordance with the estimates given.

Should it be found necessary, at a later stage, to effect alterations necessitating a change in design or in manufacture, the estimates given automatically lapse, new estimates, in regard to both cost and delivery, being solicited. Information concerning the order is furnished by the Commercial Department through the Drawing Office or Progress Office, according to whether the information affects design or delivery.

It sometimes happens that one customer's order covers more than one type of machine—that is to say, the order covers a set of parts, which may include a motor, with controller and resistance, each of these parts being manufactured in a separate department. It may be said that this is no concern of the Commercial Department, but in some factories the commercial man assists by passing extra copies of the order to the Progress Office. Assuming this is not done, the order clearly shows the various types of manufacture

OFFICIAL ORDER

FROM SALES DEPARTMENT Date..

TO WORKS MANAGER
CHIEF ENGINEER
PROGRESS DEPT.
COMMERCIAL STORE
ESTIMATING DEPT.
ACCOUNTS DEPT.

Sales Order.................................... Shops Order....................................

PARTICULARS OF ORDER

Delivery Required..in accordance with

Quotation

Schedule

Signed..

FIG. 5

covered, so arranged to allow the Progress Office to dissect the order for manufacturing purposes. All the copies made out in the Commercial Department are sent to the Progress Office, where the clerk allocates to each separate type of manufacture a works order number, this being the number used for manufacturing purposes. One copy, with the works order number added, is returned to the Commercial Department for reference purposes, copies are sent to the Drawing Office via the chief engineer and to the Estimating Department, and the other retained in the Progress Office. If more than one progress man is interested in the order, the order itself is given over to the man responsible for the controlling factor, i.e. the motor, and sub-orders are issued to the others. The next move is with the Drawing Office, dealt with in the following chapter.

The next type of factory is the one which is laid out to handle a definite number of assembled units per year, the sale of which is more or less predetermined. As an instance, we may take a medium sized factory engaged in the manufacture of one specialized type of motor-car, and assume that the output is one hundred cars per month. So far as the factory is concerned, salesmanship enters but little into the organization, for although the models are changed yearly, the factory is affected but little.

The commercial man watches the progress made, and is in close touch with the Progress Department on the matter of output, but whilst this is going on the engineering side is busily engaged

upon the next year's model. Specimen cars must be designed and built, and then these have to undergo both the mechanical and the road tests—alterations and adjustments being made as the tests reveal defects or suggest improvements. When success is assured, and a good number of orders booked, the final specifications are passed to the Drawing Office, and the commercial engineer divides his time between booking further orders and working out improvements for the following year's design.

Another factory handles a repetition line, very little variation in design being apparent. The specifications were completed years ago, and the commercial man ministers to the needs of the agents and the wholesalers, as well as direct sales to customers. Excepting in the case of small special features, no further specifications are necessary, and he advises the factory from time to time as to the number of units required, the degree of urgency (if more than one model) and investigates any complaints which may be received from the customer.

To complete this list, we may instance the case of the small foundry, this being dependent entirely upon outside orders. Here the commercial man must, to a very great extent, act as publicity man, and endeavour to secure orders. He is much in the same position as the commercial man in the first factory mentioned, as he must quote for a never ending variety of work, and, indeed, he is at a greater disadvantage, in that he has no standard to guide him. He must quote for work to the customer's own design, often being obliged to do this from a blue print, the patterns not being forwarded unless the order is secured.

The commercial man receives an inquiry for certain castings in accordance with the blue prints enclosed, the patterns for which are already in existence. An estimate, for which no data are available, must be made, and in this type of factory the estimate is drawn up by the commercial man, in consultation with the foundry manager. This is not an easy proposition, for it is well known that the ideas of different patternmakers vary, and it is quite possible that, when a quotation is submitted and the order secured, the patterns are found to be quite at variance with the calculations of the foundry manager, and either drastic alterations are necessary or the estimate given is much lower than it should be.

The commercial man here must be a wideawake individual,

for he can easily embarrass his firm when quoting. Some foundries insist upon seeing the actual patterns before quoting, but this is not always possible, for after all the supply of patterns is by no means unlimited, and it may be that those in existence are in commission in another foundry. In the case of a new customer, it is well for the foundry to send a representative to the factory with a view to studying the class of work desired, but this is usually done only when the prospective customer is within easy reach.

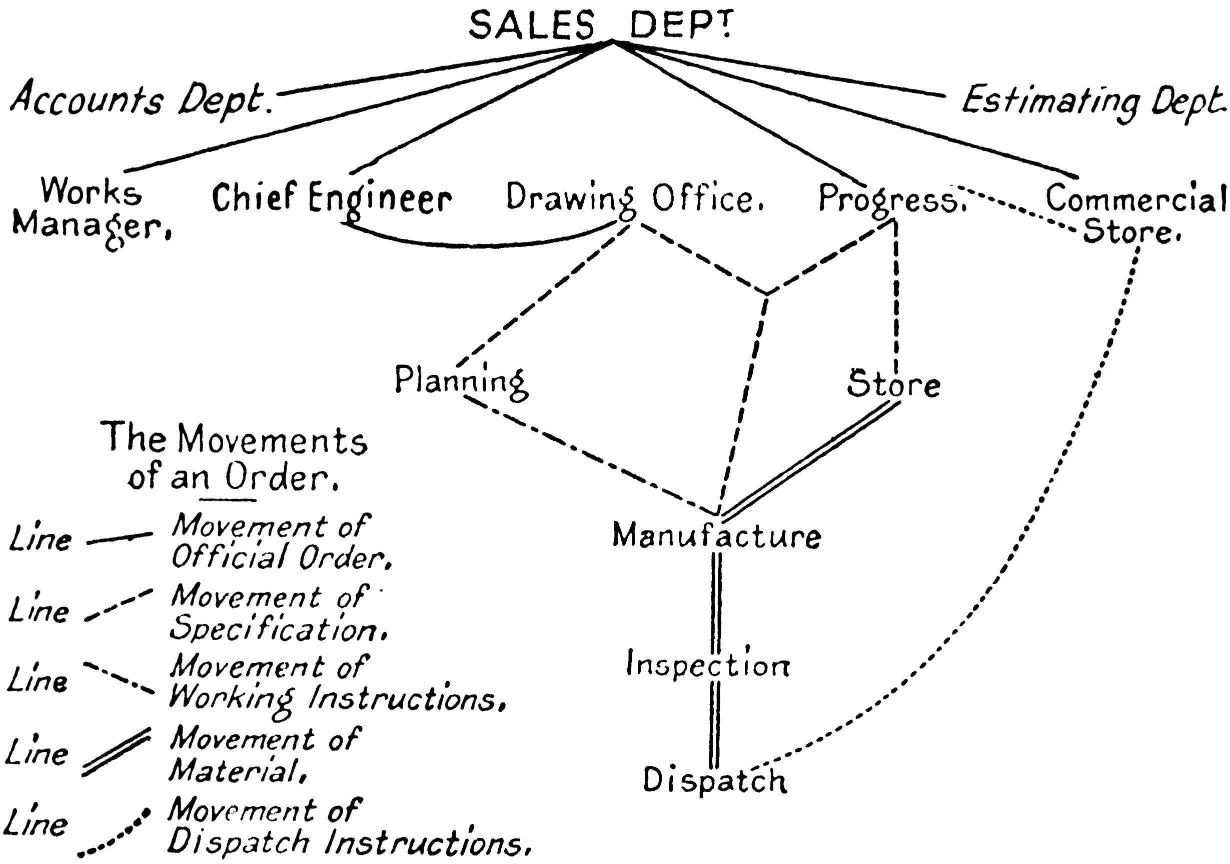


FIG. 6

Failing this (and in the absence of available patterns) a specimen casting could be sent to the foundry, and an intelligent estimate could then be prepared.

It should be the duty of the commercial man to advise the customer (or prospective customer) of any process which, if worked, will be to their mutual advantage. It may be that patterns are sent for floor-moulding, when the job could be more expeditiously handled on a machine, and when this is the case the customer should be notified, an alternative estimate being sent to show the customer how he will benefit in regard to both price and delivery. Nothing is lost, but much is often gained, by proffering this information, and the commercial man, intent upon new business, should not allow such an opportunity to escape him.

It will be observed here that the commercial man must be in constant and direct touch with the practical head of the foundry, but it does not follow that his own qualifications must not be of the highest order. He is the business man of the concern, and must remember that he is responsible for the orders which are necessary to the continued prosperity of his firms.

These illustrations show that the commercial man, or salesman, is of the utmost value to the factory, no matter what system is in force. He may not be the direct seller, but he is the accredited representative of the seller, whether he be agent or wholesaler. On the other hand, he is in direct touch with the actual customer, and must be in a position to talk intelligently. No customer wants to be told, in answer to an inquiry concerning his order, that "the matter is receiving attention," still less does he want promises which fail to materialize because they are based on nothing more substantial than guess-work.

The commercial man, though not in the actual factory, must talk and write as though he were, and for him to be able to do this he must know what is happening in the factory. He has to bear in mind that each customer is concerned wholly and solely with his own order, and he is not at all impressed by the fact that at the moment the factory is handling orders for 697 other customers, each of whom is as keen as *he* is. The system must be so devised as to offer to the commercial man all the information necessary, and in the section devoted to the Progress Department it is shown how this information is obtained.

To conclude this chapter, and incidentally to demonstrate the productive value of the commercial man, let us record that A manufactures a certain product, which B undertakes to sell. The act of selling opens up the demand for more, and so A is kept busy. If B does not sell, then there is not much point in A producing, for sooner or later he would be overstocked. Now assume that A will have none of B, and determines to sell his own product. He works for a month, and then proceeds to dispose of what he has produced, another month being taken for this. A's activities in the selling line are limited, and consequently he cannot dispose of so much as B, because his is a part-time job, whilst B makes a business of it.

It is assuredly better for A to spend his whole time producing,

and for B to be responsible for the selling, for the range of B's activities is much wider than A's, because he is an experienced seller, and as a consequence the demand is greater. The greater demand means more production and lower working costs, so that the arrangement is of benefit to both; both having a share in, and being *producers* of, the commodity in question.

CHAPTER IV

THE DRAWING OFFICE

IT is not intended to deal with the Drawing Office in regard to its organization as a designing department, but only so far as this department affects the order which has been secured by the Commercial Department in response to the quotation previously submitted. The primary instructions in regard to manufacture must emanate from the Drawing Office, who develop the broad outline of the advance specification into a detailed design and issue drawings, or references to drawings retained in the departments, so that, until such instructions are received, nothing can be done by either the Planning or the Manufacturing Departments of the factory.

Here, again, the class of manufacture handled obviously has an important bearing upon the methods employed, so we may again take as our first illustration the small electric motor. The first thing is the design, but in a majority of the cases this has been predetermined—the drawings are in existence, and it is only for modifications and alterations that the question of new drawings arises.

As explained in the preceding chapter, the specification has been drafted by the engineer in the Commercial Department, and forwarded to the Drawing Office, but this is necessarily broad in character, and leaves plenty of scope for the draughtsman in the matter of detail. Here, again, is seen that sympathetic understanding—the intelligent interpreting of the ideas of another. The engineer has something in mind which he passes to the draughtsman to develop, and the result is, as a rule, quite up to expectations.

There is a business side to the Drawing Office as well as a designing side, and it is this aspect with which we are concerned. The blue prints have to be sent to the factory, and it is necessary to know precisely where each one is. Also, blue prints in the shop must be recalled periodically for alterations to dimensions, etc., and this must be done so as to avoid, as much as possible, dislocation of manufacture.

There are several methods of making up drawings, and a few minutes' consideration of one or two of these may perhaps be worth while. In the case of the motor already referred to one drawing may cover a dozen or more different parts, these being identified by part numbers. Thus, Drawing 8952 may have twelve different parts, the rotor shaft being 8952, Part 2, the key Part 3, and so on; whilst in certain cases one or more of the parts will not be fully described, reference being made to another drawing. Thus, 8952, Part 10, refers to a rotor flange, but as this is common to more than one size of machine, the particulars of this will be found on Drawing 7261, Part 1, this number being given on the first-named drawing.

Another method is to issue one drawing covering the whole of the parts comprising one assembly, each part being detailed separately, and also shown in position. It may be remarked that when either of these methods is adopted the greater portion of the parts covered have already been made for stock, only a comparatively few of the parts requiring special attention. Even so, troubles are somewhat frequent, on account of two operators in the shop requiring the same drawing at the same time, in connection with two of the parts covered.

It is obvious that a separate drawing for each part could not be issued in such circumstances, so some firms have a given number of standard drawings, each covering a number of parts, for small details. Each of these bears an alphabetical letter, to which numbers are added as desired. Thus, one part may be known as A 31, another as P17, and so on, and this has been found to work very well.

Another method is the issue of the illustrated work card, which acts as a drawing and also as a progress record. This is effective where repeat orders are prevalent, the idea being that, with the first order, a work card showing the design of the part to be made is issued to the operator. When the work is completed the work card is returned to the Progress Office, and sent thence to the Cost Department. After the costing is dealt with, the card is again returned to the Progress Office, where it is retained until it is necessary to reissue it to the shop (not necessarily to the same operator) for further supplies of the same part.

It may be urged that this savours of progress rather than of Drawing Office procedure, but it is from the latter department that the initial issue is made, and it most certainly obviates the

necessity for the issue of blue prints for the same parts. The idea is applied only to such parts as necessitate but one or at the outside two operations, but it appears to the author to be worthy of consideration with a view to applying the method more extensively.

The most efficient method of making up drawings is undoubtedly the one part one drawing idea, which is patronized by most factories where the total number of parts can be predetermined—to the motor-car industry as an example. The drawings in the main are of a uniform size, the blue prints for shop use being mounted on card-board or 3-ply wood, and varnished to protect the print from dirt and grease. The method of handling blue prints in the factory will be dealt with later.

As before mentioned, the Drawing Office must know exactly the number of blue prints taken off a specific drawing, and where each of these prints is likely to be found. A card record is therefore brought into service, each card bearing one drawing number, and being filed consecutively. The number of blue prints made is given, together with the date, and to which departments they have been sent. It is not considered desirable to issue more than one

RECORD OF BLUE PRINTS

Drawing Number......................

Number of Blue Prints.	Department Supplied.	Received by.	Date.	Date Recalled.	Date Returned.	Received by.

FIG. 7

print to any one department, for fairly obvious reasons. When it becomes necessary to effect a change of dimension or any other alteration upon a drawing, the whole of the prints are withdrawn by the Drawing Office, and new prints issued; but it must be understood that a new print cannot be issued to a department from which the old print has not been received until a most searching investigation has taken place.

This procedure is necessary, as the alteration may affect manufacture, and it is quite possible for work to be done in accordance

with the old print, even though the new one be in the department. To quote one instance, a steel shaft was being machined to a diameter of $2\frac{1}{4}$ in., but it was afterwards decided to alter this dimension to $2\frac{5}{16}$ in. The job was not in operation at the time the blue print was recalled, but for some unexplained reason the print could not be found, and the new one was issued even though the old one had not been returned to the Drawing Office. The job was afterwards put into operation, but was rejected when it reached the assemblers, it being discovered that the shaft had been turned in accordance with the old print, and was therefore scrap.

It should be possible for a foreman to check quickly whether a blue print in his possession is up to date. One method of accomplishing this is by the use of a "Changes" column on the drawing. Against every dimensional or other alteration a reference letter or number is added and encircled. Thus on the steel shaft just discussed against the dimension that is affected the reference letter might be C and would appear adjacent to the dimension thus, $2\frac{5}{16}$ in. Ⓒ. In the "Changes" column against the reference letter Ⓒ, the date of the change would be given along with the statement "was $2\frac{1}{4}$ in." If in doubt the foreman can inquire, by telephone, say, for the latest reference letter on any particular drawing.

In connection with standard lines of manufacture, some firms issue from the Drawing Office what are known as Drawing Lists, these being blue printed sheets bearing the numbers of all drawings used in connection with a given assembly. This procedure is, in certain circumstances, very useful, and is a time saver so far as the Drawing Office is concerned, for it obviates the necessity of repeatedly quoting drawings in respect to each and every order

DRAWING LIST

Number.......................

Covering the Assembly of...

....

Date Issued. Dates Altered.

Name of Part.	Drawing Number.

FIG. 8

for the same class of work. Therefore, instead of enumerating, say, six or seven different drawings when issuing an instruction for an assembly, the whole are covered by "Drawing List Number ——," this being an easy proposition to master so far as the factory is concerned.

It is the business of the draughtsman to give the fullest possible information to the shops, for the Drawing Office is, of course, *the* instructional department in the matter of design. The actual drawings should be as simple as possible, elaboration being repressed, otherwise time and money are lost through misreading. Much delay has been occasioned by the inability of the operator (and his foreman) to interpret correctly the ideas of the draughtsman; and the necessity of the foreman to pay frequent visits to the Drawing Office in order to get a personal explanation of what is required is not conducive to efficiency nor to a tranquil mind on the part of the foreman or the draughtsman.

In the large factory, where a large variety of designs is produced, photostat copies of drawings are very useful to the heads of departments. These reproductions, reduced to handy pocket size, are more valuable to the busy foreman than are the blue prints, for they are always available, no matter where he may be. It is quite an easy matter for a foreman, when a point comes up for discussion, to take a photostat drawing from his pocket and illustrate, or have illustrated to him, the point at issue. The photostat is handy also to the progress man, for it enables him to study the design of the parts in which he is interested, so that he would be enabled to identify any part whilst engaged upon his duties.

The photostat would be too expensive to use in connection with special parts, for these (so far as any one design is concerned) would be comparatively few in number, and would not be worth photographing, unless there was a probability of repeat orders. But for standard and semi-standard lines it is a very useful process, and in time-saving well justifies the expense incurred. In the matter of alterations the photostat would be treated as the blue print, being recalled and scrapped by the Drawing Office before a new issue is made.

The compiling and issuing of Specification Lists or Bill of Materials as it is often called which indicates the materials required in respect of each drawing are one of the most important duties of the Drawing

Office, although this is looked down upon somewhat by the draughtsman, in view of its routine nature. Usually there is a definite section set apart for this work, the duties in a well regulated factory being for the most part clerical. The idea of specification lists emanating from the Drawing Office is a big advance on the old method, which necessitated the shop foremen and their clerks spending hours compiling lists of their requirements from blue prints.

The writer has recollections of long week-ends spent in this nerve racking manner, for it was not a question of one or two, but of dozens of different drawings, which had to be dealt with in connection with one assembly. The particulars were, in the first instance, written upon foolscap lists, and then classified and transcribed upon requisition forms for sending to the stores. It was almost impossible (in view of the magnitude of the job) for this to be done during ordinary working hours, and so Saturday afternoon and Sunday were set apart, and never was overtime better earned.

To-day this business has been reduced to a science, and the complete specification list follows hard upon the issue of the drawings, or, where these are already in existence, soon after the official order itself is received. No clerical work, so far as the requisitioning of material is concerned, is necessary, for at the same time as the manufacturing department receives its copy the store is similarly provided, requisitioning being quite automatic.

The Drawing Office must possess the necessary data to enable it to compile the specification list, but of what these data consist must depend upon the methods employed and the features covered by the list. It will be well, therefore, to consider what is embodied in the list, and the data necessary.

It is often found a great help to allocate a code number to each of the separate parts of the job for clear and unambiguous reference in all subsequent instructions. This will involve keeping a record of all parts and their respective numbers, which will also refer to the respective drawing, pattern, jig, etc., to prevent duplication of numbers. These may be drawn up to indicate their origin, e.g. a special part involved in order No. 760 may be referenced as 760/123 while a $\frac{7}{8}$ in. brass screw may be referred to as BS7854.

It is understood that, generally speaking, the "routeing" of material through the shops, i.e. indicating the sequence of the

various operations necessary in manufacture, is a matter for the Planning or Rate Fixing Department, and not for the Drawing Office. In the case of the small factory, therefore, which boasts of but one Machining and one Assembling Department, the compilation of the specification list is not a formidable undertaking. The drawing gives the necessary particulars regarding each part, and, taking one at random, the drawing tells us that (1) two pieces are necessary for one assembly, (2) the pieces are to be cast in iron, (3) and then to be machined to dimensions given, after which (4) they are ready for the assembler. The following procedure then is followed.

Assuming that the specification list covers 200 assemblies, it follows that 400 pieces to the drawing mentioned are required, and so this number is given. As the pieces are iron castings the following questions arise: (*a*) Are patterns in existence or must they be made? (*b*) Does the factory possess a pattern shop and foundry, or must the pieces be cast outside? Assuming that the patterns are in existence and that the factory possesses a foundry, the specification list gives the foundry as the first department, but if, on the other hand, the pieces must be cast outside, then the Buying Office is cited as the first department. In the case of new patterns being required, the first department is the pattern shop, if one is in existence, the foundry following as the next department.

As the pieces require machining, the machine shop is next shown on the list, and it will be observed that details concerning machining do not appear. All that the specification list shows is that the pieces must go into the machine shop, the fact that whilst there they must be subjected, say, to turning, milling, and drilling processes, not being recorded, as this is the concern of the shop planning. The last department shown on the list is the assembly, to which the pieces must go after the machining processes are completed.

Now let us take another drawing, which covers, say, a ball bearing, a well-known make being specified. This is obviously an outside purchase, and as, equally obviously, no machining is required, the list shows but two departments against this item—the Buying Office and the Assembling Department. But a third drawing is not so easily disposed of, for the detail covered could be made either in the factory or outside. It is not for the specification clerk to decide where this shall be made, and so the necessary information must be available.

INSTRUCTION, GIVING PARTICULARS OF WHERE DETAIL IS TO BE MANUFACTURED

TO SPECIFICATION DEPT. (DRAWING OFFICE) Date..........................

FROM PLANNING DEPARTMENT

In reference to..

Covered by Drawing Number......................................

Please note this is to be made by—

(*a*) SHOPS (state departments) }
(*b*) OUTSIDE SUPPLIER } ....

(*Strike out item not applicable.*)

PLEASE ISSUE YOUR SPECIFICATION ACCORDINGLY.

Signed..

FIG. 9

The head of the Planning or Rate Fixing Department must determine whether a detail must be made in the factory or purchased outside, and his procedure is to study every new drawing issued, and to acquaint the specification clerk of his decision. These decisions are conveyed on cards, of a handy size for filing, these being kept in the specification section under the drawing number, for easy reference.

In the case of a standard or semi-standard line of manufacture, the information derived from these cards is used for the purpose of compiling master specification lists, to which the clerk refers when handling a similar order. By this method much time is saved, as the necessity to extract information from each card covering details comprising the assembly every time a similar order appears is obviated. It is essential, however, that the master specification list be right up to date, and should the Planning Department decide at a later date to reverse its previous decision in regard to any piece due notification must be sent to the specification clerk.

Another method employed by the small factory in regard to specification lists is that, in the department columns, only the source of supply is quoted, leaving all routeing in the hands of the Planning Department. Thus, X would denote outside supply, XX from Store, F Foundry, S Smithy, and so on. This has the merit of simplicity, but very little extra trouble is occasioned in including the remaining departments, which, in the opinion of the writer, is much more effective.

In the larger factory the specification list is somewhat more elaborate, although substantially the same principle is involved. It is observed that, where numerous types of manufacture are dealt with, one manufacturing department, at least, is identified with a specific product, the Generator Department manufacturing generators, and so on. There are, however, other departments which specialize in a certain process, without being tied to one particular line of manufacture, as is instanced by the Foundry, Smithy, Press Shop, Automatic Department, and the like; whilst in other cases, owing to one or more details used on one assembly being somewhat similar to details comprising another product, it is more economical for these to be produced in the department concerned with the last-named product.

In order to illustrate this, let us assume that the specification list is concerned with an induction motor, and that there is an Induction Motor Machining Department. At the same time there is a Switchgear Department, and here are the machines specially adapted for the manufacture of small brass details for switchgear. Now only a comparatively few brass parts are required on the induction motor, and it would hardly be economical to have machines in the Induction Motor Department to produce these. The obvious course, therefore, is for these to be produced in the Switchgear Department, and so the specification clerk is advised accordingly.

In this connection, the old method was for one foreman to place a sub-order upon another foreman for special work, but this is being superseded with the rise of the Planning Department. This department is responsible for the lay-out of the shops, and it is a simple matter, therefore, for the specification clerk to get all the information necessary to embody all instructions in the specification list.

The specification section in the large factory is sub-divided so that each clerk deals with a given number of different types of manufacture, and, as there are master lists in existence for all standard and semi-standard lines, the task is not more formidable than in the smaller factory. The clerk handling definite lines, associated in the main with certain departments, speedily becomes conversant with the details and what they imply, and so long as his instructions are clear, and his information up to date, he cannot be expected to go wrong.

Where a standard specification list is issued for continuous handling over a long period, the blue printed list is the most effective. When this is used, it is necessary, in the event of an alteration, to cancel a whole sheet and issue a new one, but as such alterations are not frequent, this does not involve any considerable expense. In the factory where a specification list is issued in connection with every order, various methods are in use, these including: (*a*) hand-written lists, (*b*) typewritten lists, and (*c*) blue printed lists—printed in bulk, and quantities added to each set of details as required.

The hand-written list is quite effective where the list is in existence but a short time, but it is not to be commended, on account of the time taken in compiling. The typewritten list is much better, particularly where several copies of each list are required. Alterations are shown either by a new issue, or by the issue of a gummed slip for attaching to the original list. If it is known that repeat orders are certain, the blue prints are useful, the heading and quantities being filled in as required, but these involve a deal of trouble, apart from the fact that a very large number must be always available. The typewritten list, therefore, seems to "fill the bill," in the matter of both economy and effectiveness.

A further function often required from the Drawing Office is the designing of the product of the firm and of improving the present form of existing lines to meet changing conditions and demands. This function demands a keen knowledge of the methods of production of the article as well as all the uses which may be required of it. The cheapest and most efficient methods of production will be used while all the suggestions of the selling department will be incorporated. In making these changes the designer will aim at simplicity as far as possible without affecting its performance as well as the standardization of the parts for simplifying production.

CHAPTER V

THE PLANNING DEPARTMENT

WITH the establishment of a new factory it is possible to bring into being a Planning Department, its functions being first to lay out the shops to the best possible advantage and then to distribute the work in the manner best calculated to derive the maximum benefits from that lay-out. Unfortunately, so far as this department is concerned, in the majority of cases the factories are already in existence, and have been so for many years, and so the Planning Department finds itself called upon to "plan" upon what is already in existence, the utmost it can do being to re-arrange with a view to getting the best results, or introduce new appliances to keep the methods up to date.

In some factories even re-arrangement is not permissible, and so "process planning" devolves upon the Rate Fixing Department. This latter aspect will be dealt with in the next chapter, so for the time being it is assumed that our factory possesses a department known as the Planning Department.

It is admitted that this hardly comes within the scope of administration, but in order to discuss administration intelligently it is necessary to take into consideration every factor having any bearing upon it, and it must be borne in mind that "planning" determines to a very great extent the policy of the administration. It is not proposed to discuss planning in all its bearings, but to consider its relationship to the administrative side of the works organization.

Bearing in mind the fact that our factory is already in existence, we must consider at what point the Planning Department assumes control. We may assume, for the first illustration, that the factory is one of medium size, ostensibly laid out for a given number of assembled units. The word "ostensibly" implies that absolute precision has not been employed in the "lay-out," which was probably designed years ago before scientific principles were applied, and it will therefore be seen at once that there is scope for the activities of the "planner."

His first duty is to determine whether the existing facilities are

adequate for the return expected, and if not, to justify his presence by showing how the existing facilities are inadequate, and then by applying the remedy. His work is wholly upon the engineering side, and he is satisfied that, no matter what move he makes, the factory administration is capable of getting the maximum results from his endeavour. For example, he may introduce a method which could materially increase the production of a certain department, but if the Buying Office fails to get the extra raw material necessitated by this increase, then he does not reap the full reward of his labours. Hence, it is essential that a thorough understanding exists between these two branches of the organization, otherwise the new innovations are productive of nothing but extra expense.

The "planner" in this factory has a definite quantity to go upon, that is to say, it is known that 200 assembled units are required each month, that every section and department is wholly and solely engaged upon some part or parts of this assembly, that there are no side issues, and that, broadly speaking, the factory is capable of producing what is required, i.e. the quantity given. The fact that the factory is not, at the moment, producing anything like the number required is not indicative of its inability to do so, given the right conditions, and it is the business of the planner to procure those "right conditions."

He is assisted to a very great extent by the progress man, who knows what he wants, and who sets out to get it. This individual can, however, only get the best out of what is available at the moment, and if this best falls short of what is really needed, then it is to the planner that the progress man turns for assistance. It is a case for co-operation and mutual assistance, for each knows something which the other does not, and the diffusing of information emphasizes the need and provokes the remedy.

The original "lay-out" did not in all probability cover the efficient grouping of machines: the Machining Department, perhaps, is scattered, the fitting shop is in the least accessible part of the factory, the drilling section is too small and the milling section too large, a large block of offices occupies space which could be utilized to greater advantage, certain machines are obsolete and inefficient, the tool room is hopelessly out of date—these are but a few of the elementary troubles which are obvious to, and demand the immediate attention of, the planner.

So, methodically, he must get to work, for it must be remembered that he cannot close the factory whilst effecting improvements. The factory must continue producing, for there must be no dislocation, and improvements must therefore be gradual. It may be a re-arrangement of certain machines, or a difference in the position of the fitting benches. Final painting, which had previously been done in the erecting shop, is transferred to a new Paint Department, in order to allow more space for the erectors. It may be determined to introduce new processes, which will necessitate the installation of new machines, or it may be that one new up-to-date lathe will entirely supersede two lathes already in existence. The factory probably did not boast a gear cutting machine, as this class of work had always been done outside, but the planner may determine that it would be beneficial to have this operation performed in the factory.

He emphasizes the need for new tools and jigs, for the purpose of speeding up production, and where tools cannot at the moment be improved upon he may press for duplicate sets. One machine has always handled a specific class of work, but he considers it can do more, and so proceeds to adapt it for something else. He may consider that a certain building is not large enough, and so press for extensions, but whatever he does, it follows calm deliberation, and he is prepared to stake his reputation on the necessity of his action.

One department cannot do what is required, and further internal changes are for the moment impossible. He considers the raw material used, and calculates that a better quality will effect a marked reduction in the labour costs, this enabling the department to increase its output. Or he may determine that it would be beneficial to place certain processes with outside firms, thus allowing the part of the factory hitherto responsible for these the opportunity for concentrating upon something more important.

In this he influences the policy of the Buying Department, for if that department had, for a certain job, always bought black mild steel, it would continue to do so until other instructions are received. It will be seen, therefore, that there is plenty of scope for the planner, even to get the output up to the figure predetermined, but his work is not finished even when this is reached. The Progress Department is continually demanding more, and the

planner must make realization certain. It is out of the question to expect the management to be entirely satisfied with any given output, and it is also out of the question to assume that a factory can be organized to such a fine pitch as exactly to limit the capabilities of every section in each department to one common figure—and that the exact figure aimed at.

The factory can never mark time, and whatever move is made in one section of the factory, this is reflected in another. To reach a certain figure certain movements are necessary, and these movements in their turn open up still other hitherto unexplored avenues. The first motor-car viewed from a present-day standpoint is a crude looking object, but when it was first designed it was considered a thing of beauty. It served its purpose, however, for it opened up the way for its successors, and in the same way also the first movements of the "planner" may be so regarded.

The "planning" having been briefly described as associated with the "definite" quantity, a few words concerning the "indefinite" may be allowed. Here "planning," as popularly understood, is not so firmly established, for fluctuating conditions are factors which cannot really be overcome, although they can be controlled to some extent. Assuming that the "lay-out" is pre-existent, the "planning" seems to lie in the direction of standardization of design.

In this type of factory, although large quantities of parts are manufactured, they are put through the shops in comparatively small numbers, and it is difficult to predetermine the number of any specific part likely to be required during any given period. In the case of the semi-standard assembly, it is possible that some 80 per cent of the details used can be standardized and held in stock, and by getting the average figure for the past two or three years' output it is possible to estimate the requirements for the future, and have the details put through the shop in sufficient volume to allow for the planning of the processes.

In this case adjustments, similar to those described previously, can be made, and tools, jigs, and other aids to production can be designed. But allowance must be made in the same departments for the production of the 20 per cent special parts, and as these are of a varied character they are apt to cause some embarrassment to the planner.

The speciality may be anything. In the case of an electric motor, for instance, it may be the winding, affecting but one department; the laminations and winding, affecting two departments; or may be the shaft, end-shield, bearing, or frame. Nothing can be determined until the specifications covering the order are available, and the Planning Department cannot make provision in advance for a definite number of special end-shields, shafts, or anything else. During one period probably every order received is practically standard, except for the windings, which do not affect the Machining Department—at another time a large number of orders necessitate special end-shields, and so it is impossible for certain machines to be set apart for these specialities. They have to be handled in conjunction with the standard parts; for instance, the boring of a special end-shield must be done on the boring mill handling that process in connection with the standard variety, this obviously upsetting to some extent the estimates of the Planning Department. On the other hand, any attempt to allow for these will in all probability result in a shortage of work, so far as certain machines are concerned, and it will be observed, therefore, that "planning" must be somewhat limited, and that it falls upon the Progress Department to utilize the facilities available to the best possible advantage.

The "planner" here will go all out for standardization, and he will be a severe critic of design. In taking one line of manufacture, it is a common failing of the draughtsman to give different dimensions to a similar part, simply on account of the various sizes of the unit. That is to say, because one motor is made in three different sizes, say, numbers 20, 30 and 40, a certain detail is also made in three different sizes, although perchance one standard size would be quite suitable for all three. It is here that the "planner" is on the alert, and his criticism of design is of great value.

He aims for "stocks," and he is great on "sub-assemblies." He will assemble together all the details possible, for in this way he can cheapen production, and minimize the last operation. He does not believe in a "Fitting Department," and he endeavours to transform this into an "Assembling Department." He believes in the *work* being done at the beginning of the job, and not at the end—by exploiting the machine and reducing the hand—and in this connection it may be observed that, although at the moment

he is taking the work from the fitter to the machinist, he is contemplating going still farther forward, and the development of die casting and die pressing will enable him to do what he has in mind—to have all the real work done at the *first* process.

The "planner" is the practical man, and it is upon his findings that others act. He enables the Specification Department to prepare and issue instructions, and the Progress Department to carry them out. The manufacturing departments are controlled by him, for his methods are adopted, and the facilities suggested or provided by him are made use of without question.

CHAPTER VI

RATE FIXING

WHETHER there be a Planning Department or no, the rate fixer, whose duty it is to specify the time which an operator should be allowed for performing a certain job, has his place in almost every factory where there is any pretence to organization, especially in those factories favouring any kind of bonus or piecework system of wage payment. There need not necessarily be a special department to handle this work; indeed, in the smaller factory the expense incurred would hardly be warranted, but there is at least one person whose first duty is to fix the times or rates for each process. Such a person must be one who has a good knowledge of the machines and their capabilities as well as a wide experience of workshop practice.

Where a Planning Department does not exist, the rate fixer steps into the breach, and makes such arrangements as will ensure an equitable distribution of the work throughout the factory, consistent with the demands made in the matter of output. In such a factory he is the process planner, and although it is improbable that he can assert himself in the same manner as the individual described in the previous chapter, his recommendations and suggestions in regard to improvements, with a view to providing better facilities, merit every consideration.

The rate fixer exerts an influence over the administrative side, and particularly in regard to the activities of the Progress Department, and for that reason he merits a place in a book dealing with administration rather than with factory management. The rate fixer provides the key for the progress man, and without this the latter cannot conduct an intelligent campaign in the manufacturing departments.

The specification list, as previously explained, merely routes the various departments through which a certain piece must travel, but it does not specify the operations to be performed in each department. That is left to the rate fixer, who is supposed to determine from the drawings the most economical methods of handling the piece in the department set out on the list.

A good deal depends upon the payment system in force, for in one factory actual rates are given, whilst in another times are

favoured. One of the earliest forms of rate fixing consisted of a price being given for a process rather broadly defined, and it was left to the foreman of the section to make the job pay. As an example, a shaft required turning—the rate fixer offered for this 8s. 6d. In the turning section were men and youths engaged at varying rates (day work) and the onus was upon the foreman to give the job to the man or youth who, in his opinion, could make it pay.

It will be observed here that this was rate fixing, but without planning, and the foreman had plenty of freedom. Unfortunately, however, this did not altogether commend itself to the Progress Department, the reason being that important jobs were delayed because the "right rated" man was not available, and the foreman was afraid to give the job to a higher rated man because he could not do it at the price given. The progress man, in his anxiety to get the piece in question, would have it put through at a higher figure, and then trouble ensued with the rate fixer, who was concerned with prices and not with deliveries.

Trouble will always ensue when opposing interests clash, and so, in some factories, an endeavour was made to overcome the trouble by giving two prices for each job, one for the lower and one for the higher rated man, and although no doubt this was an improvement, it cannot be said to have been an unqualified success, for the real foundation of both progress and rate fixing—planning—was still absent.

"Time fixing," rather than "rate fixing," gave much better results, particularly when these times were calculated scientifically, and the "planning" element began to make its presence felt. The old "broad" processes were carefully dissected, and instead of one turning process there were perhaps three, and each of these covered a specific operation. This had the effect of speeding up production, and a corresponding "speeding up" of administration had a great effect upon the factory output.

The work of "Time Fixing" has not been developed in this country to such an exact degree as in America, where every operation is analysed into its constituent elements and timed with a stop watch, the total giving the time of the complete operation, distinguishing between the time necessary to set up the machine for the whole batch, and the time to run off one item from picking it up to putting it down completed. From these figures the actual time for any number of articles can be readily calculated.

In the course of this analysis, a study is also made of the precise movements of the worker involved in the operation so that unnecessary motions can be eliminated and the necessary ones improved, so that the job can be done in the minimum time with the least fatigue. It is an attempt to standardize the method of performance, as well as the time of doing a job, by teaching the employees the more effective way. It has, as its first objective, the reduction of fatigue by introducing rhythm into the movements and elimination of waste effort, but there follows naturally from its adoption increased output and standardization of the time taken.

Each operation being "timed" and placed in correct sequence enabled the progress man to "plan," and rate fixing (as we will continue to call it) and progress were no longer apart. It was not now a case of cost versus delivery, but a timed programme, calculated to accelerate delivery, and the onus was upon the progress man to get the maximum benefits and results from that programme. Thus, he in turn had to "plan." He knew how long he had to get the order through the shops—he knew the times allowed for each process on every detail connected with that order—and it was up to him to ensure that each detail was ready by the date required.

Upon receipt of the specification list, then, the rate fixer issues his process cards, it being assumed that new parts are dealt with as the drawings arrive. These cards, covering all processes, are sent to the Progress Office, together with a master card for reference.

MASTER PROCESS CARD

Drawing Number.......................... Name of Part...

Process.	Time Allowed.	
	Setting.	Operation.

Fig. 10

The first operation being put in hand, the process card for that operation is sent to the foreman of the manufacturing section, and when the operation is completed and passed by the inspector, the process card is returned to the Progress Office, and the next card given in exchange, the fact being recorded upon the master card. This method enables the progress man to know at any time the exact whereabouts of each and every detail, knowledge which is

JOB PROCESS CARD

Order Number.................................. Drawing Number..................................
Name of Component..
Process ....
Tool....................... Jig...................... Fixture....................... Gauge...................

TIME ALLOWANCE

Setting.	Operation.

NUMBER OF PIECES

On Order.	Passed.	Rejected.	To be Rectified.	To Store.
Signed .... *Rate Fixer.*	.... *Inspector.*	.... *Inspector.*	.... *Inspector.*	.... *Storeman.*

Signed...*Foreman.*

FIG. 11

extremely valuable, and which obviates a good deal of otherwise essential work.

The rate fixer, however, even in the factory engaged upon a standard line of manufacture, must be for ever effecting improvements. If a Planning Department be in existence he must be associated with its activities, and if one is not in existence then he must take its place. From his close contact with the actual processes the rate fixer is often able to make valuable suggestions for improving them or cheapening the methods of production.

Times and processes need constant revision with modern competition. Business should be for ever increasing, but with the old methods the limit of the capacity of the factory is soon reached, and then money must be turned away. No firm can afford to do this, for sooner or later the pinch will be felt. The would-be customer, who has had his order refused, does not make a second attempt, and his business goes elsewhere.

The rate fixer must do his part in preventing this. The salesman is after business, and the progress man is prepared to get through the shops all the business that can be obtained. There must be no impossibilities, for planning, from both a mechanical and an administrative standpoint, must make the seemingly impossible possible. Every man must justify his selection to the position he occupies, and he lives, not only in the past and present, but for the future.

The rate fixer makes the standardization of costs possible, although standardization here does not mean a flat level. What it does mean is that when a figure is established, that may be regarded as the maximum, and this being so, estimating for prospective orders becomes a fairly simple proposition. Before the advent of the rate fixer, the estimator had very little reliable data to go upon, and as a consequence his was a laborious pursuit, which did not even have the saving grace of yielding satisfactory results.

The estimate was "arrived at," for anything approaching accuracy was out of the question. Sometimes the estimate was too high, and then the order was lost, which was, of course, bad for the factory. And not only was this order lost, but in the eyes of that inquirer the firm acquired the reputation of being "expensive," and consequently was not invited to quote upon a subsequent occasion. On the other hand, the estimate was probably low enough to secure the order, and it was then found to be too low to make it a paying proposition. The next time that customer sent in an inquiry, the estimate had increased considerably, and the startled customer naturally wondered whether this was a ruse to force him to place his order elsewhere.

Such a state of affairs now is happily well-nigh impossible, for with an efficient rate fixer, backed up by progressive foremen and a strong administration, scientific costing must of necessity follow. The rate fixer must respond to the demands of the Progress Department, which demands are based upon intimate knowledge, not only of the actual commitments, but of the possibilities which exist in regard to new business.

The rate fixer has every opportunity in the modern factory, for he practically controls the whole of the manufacturing departments. He sets the time for each and every process, and in so doing he limits the foreman in his choice of machines. He has demonstrated that a certain process is the most economical, and that a certain machine can expeditiously handle that process. He may indicate an alternative choice, and when this is so he gives as his first choice, say, machine number 10, at a certain time; as his second choice machine number 20, and his third choice machine number 30, each with a definite time allowance. The foreman is expected to work in accordance with this programme, and any deviation is severely commented upon.

CHAPTER VII

THE TOOL ORGANIZATION

THE order may be said to have now passed the instructional stage, but it does not necessarily follow that the manufacture of every part connected with it may be commenced forthwith. It is true that the size and type of the unit have been determined, that the departments through which every detail must pass have been selected, that every process in connection with the manufacture of each detail has been determined, and that the time allowance for each process has been fixed. The manufacturing departments have received instructions, but the point to be debated is whether they have the necessary facilities for acting up to those instructions.

It is agreed that it is the duty of the Planning Department to provide the necessary facilities, and when a process is decided upon it is assumed that the department concerned can work in accordance with the instructions given. There is no doubt that, so far as machine tools are concerned, these are already in evidence, but it is with the aids to these, in the form of patterns, special tools, jigs, fixtures, and the like, that this chapter is concerned.

Thus it is that the tool room organization comes up for review, but before dealing with this it will be well to consider once again the class of manufacture concerned, in order to appreciate the importance of the tool room in connection with it.

In the case of a standard type of manufacture, where the work is put through on a repetition basis, it is quite probable that the tools are already in existence, and, therefore, manufacture can be proceeded with without delay. There is no call for special tools, and so long as the process remains unchanged, the tool-maker's activities are confined to the upkeep of those tools, and to the replacement of those which can no longer be repaired to advantage.

This is a by no means simple proposition, for it must be remembered that every tool must be kept in good condition against demand, and that all repairs and alterations must be made with due regard to the commitments of the Manufacturing Department. It is in this connection that the tool room forms part of the factory

administration, for it is there to facilitate production, and not to retard progress.

The foreman of the Manufacturing Department has a right to expect a tool to be available upon demand, and to be in proper working condition. He does not expect to be told that it is undergoing repair, neither does he expect to be obliged to return a tool because it is in bad working condition. In the matter of maintenance the principle is for every tool to be inspected before being placed in the tool store, and if repairs are necessary, for these to be effected at once.

As an example, let us assume that a certain drilling jig has been in commission, and just released. The operator returns this to the tool store, but the storekeeper, instead of putting it into stock, passes it along to the tool inspector for checking. If O.K. it is returned to the tool store, but if repairs are necessary, a report covering these repairs is made out and sent with the jig to the tool room. A copy of this report may be sent to the Progress Department, or, if this is not considered desirable, then a daily list of tools returned to the tool room for repair should be sent.

NOTIFICATION OF TOOL UNDER REPAIR

TO TOOL STOREKEEPER, PROGRESS OFFICE. Date..............................

FROM TOOL INSPECTOR

Please note that Tool Number..............................

Jig Number ....

Fixture Number ....

Gauge Number..........................

Used in connection with process..

For Component.. Drawing No................

is being taken in hand for REPAIRS, and should be ready for use not later than..

Signed..

Tool Inspector.

FIG. 12

It is necessary that the Progress Department should have this information, for in most factories the tool room is never at a loss

for work, and it is almost impossible for all repairs to be effected expeditiously. Consequently, there is grave danger of the Progress Department issuing orders for which the tools are not available. and then trouble ensues in the Manufacturing Department, and work programmes are dislocated. The Progress Department, armed with this information, is enabled to advise the tool room of the relative urgency of tools sent in for repair, and thus the tools most urgently required are given preference, and the tool-maker can plan his work accordingly.

It sometimes happens that the tool inspector determines that a certain tool cannot be repaired, and he forwards a recommendation that this be scrapped and a new tool made. Here, again, the Progress Department must receive notification, otherwise production may be adversely affected. It may be that the old tool, bad as it is, is still capable of further service, and where an urgent job is affected the progress man may suggest that it be used for the purpose of getting through a smaller number of parts than is usual, in order to maintain output, the new tool being put in hand whilst these parts are being produced.

Much delay and confusion have been caused by lack of co-operation between the tool room and the Progress Department, all of which could have been avoided had a proper understanding existed between these departments. The tool-maker (or planner, or whoever is in authority) may argue that he does not take instructions regarding the reliability or otherwise of a tool, but really this point does not arise, as there is no attempt on the part of the progress man to dictate. It is more a question of the tool-maker appreciating the responsibilities of the progress man—of remembering that he is committed to a certain output, and that he alone knows the state of the stocks, and how output will be affected by the decision to make a new tool. Before the question is finally decided, he should at least be notified of the intention, and his statement obtained regarding the effect. It may be that the tool is absolutely unserviceable, and if this is the case, then it must be withdrawn, no matter what the effect may be. He will, at all events, understand the position, and thus be able to minimize any bad effect by a judicious modification of his programme. On the other hand, assuming that, say, a further one hundred details will save the situation, and the tool is capable of producing these, it is folly for so-called dignity

to stand in the way of a solution. In any case, the final decision rests with the tool-maker (or planner) and the progress man must perforce abide by that decision, but he should at least have the opportunity of knowing what is being done.

This, then, is what concerns the tool room, whilst the original processes remain unchanged, but in the up-to-date factory, even though work is put through on a repetition basis, processes do not remain the same. The planner is constantly on the alert, seeking to provide the facilities to meet the ever increasing demands, and incidentally to lower working costs. To do this processes must be changed, and new tools are consequently required.

A new process necessitates much forethought, and before it can be brought into being the consequence must be appreciated. It must be known what should be provided, what the expense will be, and what will be the ultimate gain. To do this new tools must be designed, the cost ascertained, the time it will take to produce these—what the new process is—what will be the new time allowance—the rate of the operator, and what effect it will have upon other sections of the factory, and upon the other details comprising the unit. When it is determined that the change is a paying proposition, the state of the stocks must be ascertained—not only the stocks of that specific component but also the stocks of those components likely to be affected by the change.

It may be necessary to produce a further number of details under the old process, or again it may be necessary (on account of large stocks) to advise the Progress Department not to issue any further orders for these parts until the new tools are ready. Then the processes must be changed (the progress office again being advised), the new time allowance given, and the new tool order and drawing issued. When this is done it is possible for the progress man to get an estimate regarding delivery from the tool room, and the manufacturing programme can be reconstructed accordingly.

Turning to the factory which is interested in special lines of manufacture, the tool room has a definite effect upon the customer's order, seeing that any special tools which may be required cannot be designed until the drawing for the part to be manufactured is issued. It may be possible in some instances to pass an advance copy of a drawing to the Planning Department, but even here there is very little time to spare, seeing that there is only a

comparatively small margin of time between the acceptance of the order and the issue of instructions to the manufacturing departments.

It sometimes follows that, although the unit is being specially manufactured for a customer, certain of the components are similar to those supplied in connection with previous orders (not necessarily for the same customer), and when this is the case it is probable that tools and jigs are already in existence. In other cases existing tools and jigs can be adapted for the special requirements of a certain order, the component parts, although special in a narrow sense, being substantially the same as those for which the tools were originally made.

When the order covers components which are definitely special, the question arises whether the making of special tools and jigs would be a paying proposition, and here the planner must consult with the commercial engineer as to (1) whether the quantity of parts to be produced will warrant the expense incurred in making new tools, and (2) whether, although the quantity of parts covered by a specific order is too small to stand the expense, there is a probability of the utilization of the tools in connection with parts required on subsequent orders.

The first question can usually be answered by the planner himself, and in regard to the second, the engineer can usually determine the possibilities of future orders of somewhat similar construction. The engineer's business is, whilst conforming to the customer's specification as much as possible, to endeavour to bring that specification within the scope of the firm's definite type or style of manufacture, eliminating as far as possible all that is ultra-special by embodying specialities which can be adapted from something in existence, or which can be made adaptable for another purpose subsequently.

When, however, the absolutely special unit must be produced (and the engineer must not turn away an order because he cannot get the parts to conform to any one of the firm's recognized specifications), it will probably be decided to forgo the manufacture of the more expensive tools, and make only such tools as are really indispensable. Thus, although lathe cutting tools and the like must be specially made, milling and drilling jigs are passed over in favour of "marking out," i.e. doing the job with the tools already available

but treating each piece as a special piece to be separately drawn up and set in the machine, seeing that the extra time taken for these operations can easily be covered by the price received for a really special unit.

The expense incurred in making a special drilling jig for, say, two or three components is not warranted, and apart from this, there is the probability that the time spent in the tool room upon the production of this jig will seriously delay production of another tool which is really indispensable to manufacture. A special piece can be "marked out," drilled, assembled, and the unit dispatched in the time necessary to produce the jig—a fact which is not always remembered.

When it is decided to make special tools and jigs, it is essential that due regard be paid to the sequence in which they are required. It is obvious that, if a special tool is required for the first process, then that tool must be produced before work on the order is commenced, and no good purpose would be served by completing a drilling jig, probably required for the third or fourth process, in advance of the tool required for the first process. It is equally certain, however, that the drilling jig will take longer to produce than the lathe tool, and so it may be necessary for both the lathe tool and the drilling jig to be taken in hand at the same time, in order for the latter to be ready when required, and so obviate delay in manufacture.

Another point to be remembered is that all the component parts of one unit do not take the same amount of time to produce, and preference therefore must be given to tools required in connection with the "long operation" components. One component can perhaps be completed in two processes, a special tool being required for the first. Another can perhaps be completed in eight processes, a special tool being required for the third, and it is obvious, therefore, that the last named tool must have preference, even though this means that the first component must remain in its raw state long after the second has passed through three or four stages. The tool room must therefore have completion dates of each order, as described in the next chapter.

CHAPTER VIII

TOOL ROOM ORDERS

It is an erroneous belief that the tool room is an independent unit, outside the works organization. As a matter of fact, it is one of the greatest forces, and as such it must be exploited to such an extent as to ensure its efficiency being directed in the right channel.

No section of the factory can be termed independent—no department can pursue its own course, regardless of the claims of others. Every department, except the dispatch, is a feeder, and feeding must be conducted in such a way as to ensure the best possible result. And, bearing in mind that the tool room must feed the manufacturing departments with the essential aids to production, it is obvious that there must be a bond of sympathy between them, and that co-operation and co-ordination cannot be dispensed with.

The tool room cannot feed with what it likes, and when it feels inclined; it must be guided by the desires and the requirements of the Manufacturing Department. This department cannot exist without material to operate upon, neither can it exist without the means of operating. We must conclude, therefore, that the tool room must, like every other department, be controlled, and although there is no interference so far as the actual work is concerned it is certain that, for the purpose of efficiency, the tool-maker must work to a programme, and it is proposed in this chapter to demonstrate how this is done.

It is understood that the tool room works in accordance with instructions from the planner, who is thoroughly conversant with the needs of the factory. His business is to provide the necessary facilities for production in the matter of mechanical appliances, and in this matter he is in close association with the tool designing office. The idea is mapped out and sent to the office for the permanent design to be made.

In issuing an order for a new tool, it must be borne in mind that this is of interest to the Costing Office as well as to the tool room, inasmuch as all costs should be classified. In too many factories tool room costs are reckoned in the aggregate, it being impossible by lack of system to make an intelligent dissection, and this is harmful alike both to the works manager and to the tool-maker.

The latter is probably a hard-working and a conscientious individual, but in the aggregate his costs are heavy and the works manager is up against him.

"The tool room is costing too much—we must reduce expenditure," is the cry of the works manager, and he is scarcely to be blamed for the conclusion he has reached. Yet, had the tool room been properly organized so that intelligent costing could follow, in all probability the demand for reduction would never have been made. On the contrary, keen appreciation of the toolmaker's ingenuity would be shown, for actual results would be in evidence.

It would be shown that the money spent covered the cost of certain new tools, which had effected a large saving in productive costs—the cost of maintaining and the cost of improving existing tools. On the other hand, there would be a check against the tool room—too much money being spent on repairs, and the like. In any case, an organized tool room would open up the way for honest and intelligent criticism, which is beneficial to all concerned.

New Tool Order

Let us deal first with the New Tool Order. This emanates from the planner, who writes up, in duplicate, a New Tool Card giving particulars of the tool required, the operation and the component part, together with the model or type of unit in connection with which the tool will be used. The two cards are then sent to the Designing Office for an order number to be allocated.

The order number consists of the drawing number of the detail for which the tool is required, plus the tool design number, together with a symbol denoting the classification of the tool. This sounds

NEW TOOL ORDER

No..................

To.. Date..................................

Please put in hand the following work and charge all material and labour in connection with the same against the above number.

Particulars..

For Operation ....

Name of Part...

To be Completed by............................ Signed..

Work Commenced.................................. } Signed..

Work Completed .... } *Foreman.*

FIG. 13

rather formidable, but really it is not so. The component drawing number is already known, whilst the classification symbol and the tool design number are arrived at in the following manner. The classification symbols are letters, G for gauge, J for jig, T for tool, and so on, whilst under each of these the tool draughtsman compiles a register of numbers, commencing with 1, these numbers being used consecutively.

Thus a new tool card is received in the Designing Office, and it is known that a drilling jig must be made for a certain component, which is to be manufactured in accordance with Drawing Number

TOOL AND JIG REGISTER

No.	Name of Tool.	For Component.	For Process.	Date Appd.
T 1				
2				
3				
4				
5				
6				
7				
8				
9				

FIG. 14

1057. The tool draughtsman turns to his register under the heading of J, and discovers that numbers 1 to 50 (inclusive) have already been appropriated, and so he allocates the next number (51) to this jig, the number of the card therefore reading 1057 J 51.

It may be considered desirable for the tool-maker to give an estimate of the cost of the tool before the work is begun, and if so, the cards, with the design of the tool (the latter, of course, bearing the number as well as the card), are sent direct to the tool-maker, who puts his estimate upon the cards, which are then returned to the planner for his confirmation. Assuming that it is the practice to forgo this estimate, the new tool cards and the design are sent from the Designing Office back to the planner, who retains one

card upon his file and sends the other (with the design) to the tool room, via the Progress Office and the Cost Department.

It may be questioned why the card cannot go direct to the tool room, but it must be remembered that the Progress Department has an interest in new tools, seeing the vital effect they have upon manufacture, and it is necessary that a date be given for completion, in order to obviate any possibility of delay in manufacture consequent upon the late arrival of the tool. The date then is put upon the card, a reference to this made in the Progress Office, and the card is dispatched to the Cost Office. The cost clerk notes the card number for costing purposes (to be described later), and then the card is sent to the tool room.

The tool-maker arranges his tool cards in accordance with the dates thereon, giving due consideration to the amount of work involved, and the time necessary to complete this. If castings are required, he must give the necessary instructions to the pattern shop and the foundry (or Buying Department), and upon every requisition sent he must quote the order number given on the card. This applies equally to all requisitions on the stores for material, and to sub-orders on other departments for work in connection with the tool, such as machining, etc.

When the tool is completed, it is numbered in accordance with the number given on the card, and is sent to the tool inspector, and thence to the tool store. The card is signed as complete by the tool-maker and returned to the planner who adjusts his own card, and then sends the working card to the Progress Office. Here due note is made of the completion, and the card is sent to the cost clerk, who cancels it and files it for reference.

Maintenance of Existing Tools

We may now deal with the maintenance of existing tools, and it is in this connection that the costing is oft-times unsatisfactory. Hundreds of little jobs, and many big ones, are passed into the tool room every week, and unless proper precautions are taken no authentic costs can be recorded. The tool-maker has been allowed a lot of latitude in this respect, but this has not always proved to him an unmixed blessing, for, as previously explained, he is open to a good deal of criticism, which, in the absence of records, he is not always able to refute. In his own interests, therefore (apart

from the broader issues), it is desirable that he should be somewhat controlled, and so bring into the limelight the many happenings which are now in the dark.

The initiative in regard to tool maintenance is taken by the tool inspector, who, as explained in the previous chapter, systematically overhauls every tool released from the manufacturing departments prior to its being placed on the active list in the tool store. His duties, however, cover a somewhat wider range, for he notes the condition of every tool, and although one may be passed as fit for further service, it is not in the best of condition. He makes a note of this, and when the opportunity occurs at a later date, he makes the suggestion that the tool be taken from the store and put into good condition.

Instead of maintenance work being carried out wholly upon the responsibility of the tool room, the better method is for this responsibility to be thrown on to the planner, the tool-maker acting in an

TOOL MAINTENANCE

NUMBER T.M.

To.. Date..................

Please overhaul and put in good repair, charging all material and labour in connection with the same against the above number.

Name of Tool..
For Operation ....
Name of Part..
To be Completed by............................ Signed..
Work Commenced................................ } Signed..
Work Completed .... } *Foreman.*

(Front)

....

To Planning Dept. Date.......................
From Tool Dept.

Tool Marked ....
For Operation ....
Component..

Should be Put into Repair.

Please Confirm ....

Signed..

(Back)

Fig. 15

advisory capacity. A card, similar in design to the new tool card already described, but of a different colour, is issued by the planner

as an order, but before he can do this it is necessary for his attention to be drawn to the need.

The tool-maker (or inspector) holds a number of these cards, not appropriated to any specific order, and when he desires to recommend that an order be issued for the repair of a certain tool, he takes one of these cards and writes the particulars on the back in the manner shown in the illustration, and sends this to the planner. If the planner endorses the recommendation made he makes out the Maintenance Tool Card (in duplicate), using the card containing the tool-maker's recommendation as his own office copy, and sending the other to the tool room by the method adopted in connection with the new tool card. The tool-maker charges all labour and material costs against the order number given (which is the number borne by the tool, with the letter M prefixed to denote Maintenance), and when the work is completed returns the card to the planner, by whom it is forwarded to the Cost Office via the Progress Department.

In the case of small adjustments to tools necessitating but a small amount of time, it is not practicable for orders to be issued in each and every instance. The costing of these small jobs is dealt with under the heading of "Miscellaneous," but as it is desirable that these be kept as low as possible, the tool-maker should forward to the planner a weekly return showing particulars of the jobs so treated.

Improvements

The other category of tool costs comprises improvements to existing tools, as apart from ordinary maintenance. That is to say, a new process is devised, or a variation to an existing process, which demands a definite change so far as the tool is concerned. At the offset, it appears that a new tool is required, but fuller investigation shows that it is possible to adapt the existing tool. Then comes the question of economy—would it be more expensive to adapt the existing tool than to scrap this and make a new one? On the other hand, the tool-maker may conceive a notion of improving an existing tool in a manner beneficial to production, but whether the idea springs from the planner or from the tool-maker the twain must consult together before a decision can be reached.

Assuming that it is decided to improve an existing tool, the

expense incurred must be kept apart from that incurred in connection with either new tools or maintenance, i.e ordinary wear and tear of existing ones. The cost of the new tool is the initial cost—that of maintenance purely supplementary and directly chargeable to the tool. The "improvement" cost is an economic one, designed to obviate the necessity for a new tool, and although this cost is chargeable to the manufacture of the component for which it is intended, it cannot be charged against the tool in the same manner as wear and tear.

The order to the tool room follows the same procedure as the other orders already described, and the design of the tool card is substantially similar to the others, except that a distinctive colour

TOOL ALTERATIONS

NUMBER T.A.

To.. Date..................

Please put in hand the following work and charge all material and labour in connection with the same against the above number.

Particulars..

Name of Tool...

Name of Part..

To be Completed by............................ Signed....................................

Work Commenced................................ } Signed....................................

Work Completed .... } *Foreman.*

FIG. 16

is used, and the prefix letter A denotes that the order covers an "adaptation." Thus, we get cards of three distinct colours, which may be classified as follows: White (new tools); pink (maintenance); and green (adaptations and improvements).

These distinctive colours are of great assistance to the tool-maker and also to the cost clerk, for at a glance the former can see his commitments in regard to each class of work, whilst the cost clerk can, in the first instance, merely by the colour, place his cards in the correct category for recording; thus obviating the necessity for reading each card before the classification can be ascertained.

In certain cases tools and fixings are designed which cannot be identified with any specific component part, these being for general shop use. In the issue of orders for these, therefore, a component drawing number cannot be used, and so, for identification purposes, the letter S is prefixed to the symbol denoting the classification of the tool, so that the order would read "S.J. 10"

(standard jig, No. 10); S.G. 31 (standard gauge, No. 31), and so on. Otherwise the orders are handled in the same manner as those already dealt with.

Tool Grinding

In the matter of tool grinding, there is no object in enumerating the whole of the details handled, and for costing purposes this could all appear under one definite number, identified with tool grinding. It may be considered desirable that the weekly or monthly cost be kept for comparison, and if so, the number could be changed weekly or monthly, as desired.

Wages

It has already been mentioned that all requisitions for material, and for all work done outside the tool room, should bear the order number of the specific tool, so that all charges are recorded against it, and it is understood that these requisitions, when cleared, must be sent to the Cost Office, together with the time spent and the amount of material supplied. It must be borne in mind, however, that the order card for tools does not reach the Cost Office (after its initial visit) until all work covered has been completed, yet wages payments are being made weekly and must be properly classified. It may also be observed that it does not always follow

WEEKLY TIME SHEET FOR DAY WORKERS

Operator's No................ Name..W/E............19....

Tool No.	For Drawing No.	Name of Tool	Details of Operation	Time in Hours						Total Hours	Rate	Cost
				W.	Th.	F.	S.	M.	Tu.			

Signed.......................................*Foreman.*

FIG. 17

that, even in the tool room, one man only is responsible for the whole of the work in connection with a specific order, and so it is necessary for a medium to give the cost clerk a weekly notification concerning the payments made for wages.

Assuming that the tool-makers are day workers, i.e. paid by the hour, the weekly time sheet, similar to the one illustrated, will be found to meet the case. Each man is given one at the commencement of the week, and each day the man shows how his time has been spent, giving the tool order number (taken from the card) and the number of hours to be charged against it, these times being checked daily by the foreman tool-maker. The time sheet is so designed that two definite totals may be obtained—one showing the total number of hours worked each day, and the other showing the total number of hours worked on each job during the week. These time sheets take the place of orders, and are sent at the end of each week to the time clerk for payment, and thence to the Cost Office for dissection.

Cost Office

We may now consider, briefly, the method employed by the Cost Office for recording costs. The cost clerk has a set of cards, filed consecutively under the component drawing number, and each card is divided to allow for the cost of all tools made for use in connection with that component. Upon the front of the card the new tool costs are recorded, and upon the back all subsequent costs. This makes it an easy matter for the works manager to get at the costs of all tools made for a specific component, whilst a glance at the manufacturing cost card will show the advantages derived from those tools.

As before stated, whenever a tool order card is issued (whether this be for a new tool, improvement or maintenance) this is sent at once to the cost clerk, who notes it upon his costing card and then sends it to the tool room. This is by way of notification that work in connection with that order may be put into the shop at any moment, and from that time he may expect to receive requisitions, sub-orders, and work time sheets bearing that order number. The costs are recorded as the information is received, and until the tool order card is received in the Cost Office as a completed order, any time or material under that order number may be charged

TOOL COST CARD

Drawing No..................... Name of Component.. Type of Apparatus ....

First Costs (for Maintenance Costs, see over)																	
Tool Number.. For Process—						Tool Number.. For Process—						Tool Number.. For Process—					
Date	Wages	Total Wages	Material	Total Material	Total Cost	Date	Wages	Total Wages	Material	Total Material	Total Cost	Date	Wages	Total Wages	Material	Total Material	Total Cost

Fig. 18

The back of the card is similarly printed, except that the words "Maintenance Costs" appear in place of "First Costs."

against it. When once the completed card is received in the Cost Office, however, the order is considered closed, and any subsequent requisitions or time sheets received are referred back to the tool room or Planning Department.

The workers' time sheets are received in the Cost Office weekly, and are dissected so that the correct charges are made against each order. It will sometimes be found that more than one time sheet each week has reference to the same order, one man perhaps booking 3 hours Monday, 2 hours Tuesday, and 4 hours Friday, whilst another books 8 hours on Wednesday. As no time was booked against the order on either Thursday or Saturday, it is assumed that work in connection with the same was in abeyance on those days.

This has proved to be a very simple yet effective system of tool room organization, and has the effect of keeping the manufacturing departments in close touch with the activities of the tool room. There is no question of interference with the legitimate duties of any department, and the result is as beneficial to the tool room as to the works management. A system is no system which has a number of loose ends, and the fact that the tool room ministers to the needs of the manufacturing departments puts the former in the same position as the shopkeeper who, when a customer demands cheese, supplies that commodity, and does not try to put him off with a pound of soap.

CHAPTER IX

THE PATTERN SHOP

THE organization of the pattern shop is somewhat similar to that of the tool room, the difference being that, whereas the latter caters for the needs of the whole factory, the former is concerned with the needs of one department—the foundry—whether this belongs to the factory or to an outside firm.

In the factory where the manufactures are many and varied, so that the number of castings off each pattern is comparatively small, wood patterns are used for working purposes, and the whole of the business falls under the heading of wood working, but in the repetition shop, where hundreds or perhaps thousands of castings are wanted from one pattern, then steel, iron or brass working patterns must be provided.

In the first named factory the cost of the patterns is charged against the customer's order, and a copy of the specification list sent to the pattern shop constitutes sufficient authority for the pattern-maker to proceed with the work. In such a factory, too, it is advisable for the pattern shop and the foundry to be under one department manager, so as to permit of amicable working arrangements.

Owing to the fact that a customer's order is accepted on a definite delivery date, and that this is usually cut fine in order to secure the work, it is obvious that the time taken in making patterns must be curtailed as much as possible. For this reason (as well as for the purposes of economy) the pattern-maker endeavours to adapt an existing pattern rather than make a new one, and a very complete register of existing patterns is therefore necessary. Sometimes it is possible to give the Drawing Office these particulars, and then wherever possible a pattern is selected, and a print showing the modification is issued to the pattern shop. Where, however, the initiative is taken by the pattern-maker, it is well for the Drawing Office to issue an advance pattern drawing, so that, should it be necessary to make a new pattern, the work is well in hand by the time the specification list is received.

In the repetition factory a much more comprehensive pattern

system is necessary, for here, as with the tools, the patterns are charged against the manufactured product. It is proposed to explain this by giving a pattern system for a small factory, similar to the tool room system already described, and it may be said that this can be effectively handled by the tool room, with very little addition to the existing system.

The whole of the working patterns are of metal, for it is understood that some thousands of castings are required. In certain cases small patterns are made of steel, but in the majority of cases wood master patterns are made, from which iron or brass castings are obtained for working up for use as patterns.

This scheme allows for the pattern shop and the tool room to be worked in conjunction, and, just as the planner initiates the movement in connection with tools, so also does he in connection with patterns. It may be that patterns for all parts required as castings are already in evidence, but the factory being progressive, there is ample scope for the pattern-maker in the making of new patterns to replace old existing ones, repairs to existing patterns, adding to the number of existing patterns, altering patterns in accordance with new ideas with a view to facilitating either the casting or machining, making plate patterns for machine moulding, and the like.

It having been decided to make a new pattern, the same procedure is adopted as in the case of a new tool, viz., the issue of a new order card, the classification letter in this case being P, representing "pattern," it being understood that the first order card issued in connection with a new pattern refers to the wood master pattern. The operator books his time upon a weekly time sheet, and the particulars regarding the wood used are entered on the back of the order card. It is predetermined, of course, whether the working pattern is to be used in connection with machine or floor moulding, and the necessary arrangements made regarding contraction in casting, etc.

The new order card is closed immediately the wood master pattern is ready for the foundry, the card then being sent to the Cost Office, the cost clerk completing his records so far as the wood pattern is concerned. He knows, however, that this does not mark the complete cost of the patterns, and so he leaves sufficient space to record costs in connection with the working patterns, for which he will receive a new order card in due course.

The completed wood pattern is received into the pattern store, and the planner notified that it is ready for the foundry. If the foundry is situate in the factory, the planner sends through an order for a number of castings (six or twelve, or the number he desires) to the Progress Office, this order being transmitted to the foundry. If the castings have to be obtained from an outside foundry, the notification is sent to the Buying Office, the metal in which the castings are required being described (cast iron, brass, etc.), and should a plate be required this, too, is ordered.

Nothing more can be done until the arrival of the castings, and when these come to hand another pattern order card is issued in precisely the same manner as the former, the same procedure being followed as in the case of a new tool. When the metal working patterns are completed they are sent to the pattern store, notification being sent to the interested parties, and with the receipt of the completed card the cost clerk can make up his charges.

When the new patterns supersede those already existing, these latter are recalled from the foundry and destroyed, but if the new patterns are merely additional, then these are distributed as required.

It should be a standard practice that, at the completion of an order for castings, the patterns should be recalled for overhauling, this even though it be known that a further order will be placed immediately. So much depends upon the pattern that no risks should be taken, for it is well known that patterns do not improve with work. Many a firm has been exercised over the variability of castings, which has later been traced to defects in the pattern which have been aggravated by neglect.

Repairs and improvements to existing patterns are handled in the same manner as repairs and improvements to tools, and if the tool room and pattern shop are under one head, as suggested earlier, then the same style of card can be used. After all, the pattern is a tool, and can be treated as such, for the pattern obviates the necessity for tools in many instances.

This scheme will probably commend itself to the manager of the small factory, for in this there is no necessity for elaborate organization. Where the pattern-making is done outside, of course, different conditions prevail, but most works managers are sensitive about patterns, and would much rather handle them in the factory.

Lack of system has in the past made this the reverse of paying, and rather than institute an expansive organization many managers have placed the work outside. With a system similar to the one described, it is possible for any factory to tackle its own patterns, assuming that the necessary working space is available.

CHAPTER X

MAINTENANCE OF PLANT

At this point, a few observations on the organization governing the millwrighting and electrician's departments may be of some interest. Apart from the removal of machines, and placing in position of new machines, the first aim of the millwright is to ensure that the plant is kept at the highest degree of perfection, and the second to see that repairs are effectively and expeditiously carried out. It is observed that the first aim is by far the more important, for if this is handled conscientiously and efficiently the need for the second is minimized. Still, in spite of all precautions, machines will break down, and it is when this occurs that expeditious handling is appreciated.

Where there is a works engineer, this individual, of course, assumes complete responsibility for the plant, and it is to him that the planner or the production manager turns for the facilities to meet the demand. In many of the smaller factories however, the planner himself assumes the role of works engineer, and it is the millwright from whom suggestions regarding the plant emanate.

The millwright, from daily association and close observation knows the actual state and condition of every machine, and his advice merits every consideration. He is not concerned with the relative merits of different makes of machine, and he does not make the suggestion that "so and so" machine would handle that job better than the machine now in commission. He is concerned with the condition of the last named—whether it can stand the strain, or whether he can make it do so. In the absence of actual breakdowns, he surveys every machine periodically, and should one need repair he takes the earliest opportunity of effecting this.

It may be that certain parts should be replaced, and these must be obtained from the makers, or it may be that, in his opinion, the machine is worn out, and that it would be cheaper in the end to replace it with a new machine rather than repair it. He does not possess the authority to decide, but he forwards his representations to the proper quarter, and if the decision is against him then he

must do his best to keep the machine effective. So long as his report is made he cannot be blamed for what may happen.

Despite the periodical survey of all machines, breakdowns will occur, and when this happens it is the duty of the department foreman to send a notification to the millwright without delay, a copy of this notification being sent to the Progress Office. It must be remembered that immediately a breakdown occurs an operator is idle, and a certain process of manufacture is at a standstill. This means that the planning programme is temporarily dislocated, and, unless the trouble is speedily remedied, the effect is felt in other sections. One detail is planned in conjunction with another, and one cannot suffer a set-back without the other being affected.

The progress man, realizing what is at stake, follows up the notification, and ascertains from the millwright the approximate time it will take to put the matter right. If the trouble is but slight, probably no further action is needed, but it may be that a casting is required, and then an order is rushed through to the foundry with all speed. As this will take probably a day or two to cast and machine, it must receive constant attention and, apart from this, a revision of the programme is necessary in order to limit the effect as much as possible. Prompt measures and quick decisions are necessary here.

Belting troubles cause a good deal of delay unless dealt with promptly, and here again a periodical survey is essential. Much depends upon the discrimination displayed in selecting the belting most adaptable to the conditions under which it is run, and the millwright who goes "all out" for leather, or balata, for the whole shop, without advancing any qualifications, is courting trouble. A machine engaged upon a certain process, handling a given type of product, under a certain drive, and in given circumstances, must have the belt which has been proved to be the most adaptable, whether this be leather, cotton, balata, or other material.

Turning to the electrician's department, the same characteristics must be displayed. The machines cannot run without power, and artificial lighting is necessary for a good portion of the year. Periodical surveys are again necessary, and reports concerning the condition of the motors and accessories must be made. The tendency to overload electric motors is very prevalent, and the

electrician must not hesitate to protest. In the event of break-downs, short circuits, and the like, prompt notification must be sent to the electrician, so that the trouble may be obviated with the least possible delay. The lighting arrangements must be intelligently carried out, lamps being supplied to suit the conditions, in order to ensure the best possible results.

CHAPTER XI

THE COMMERCIAL ACTIVITIES OF THE PROGRESS DEPARTMENT

THE introduction of the progress system necessitates the creation of a new department, the personnel of which is comprised of business men, possessing commercial and organizing ability to a marked degree, and yet not without the qualifications necessary to enable them to appreciate the engineer's standpoint. Thus, an entirely new profession comes into existence, and it may be said that the duties of the progress man are unique; so unique as to be not wholly comprehensible to those not actively engaged in connection with the Progress Department.

The Progress Department having thus been introduced, it is proposed in this chapter to concentrate upon its commercial value, leaving the organization, as it affects the manufacturing departments, to be dealt with later. It may now be considered a *liaison* department, bridging the gulf which hitherto divided the commercial departments from the works.

The Sales Department, intent upon getting business, must have reliable data upon which to work, which means that accurate information concerning cost and delivery must be available to enable it to quote. This is particularly applicable to the concern interested in a number of different semi-standard lines of manufacture, such as electric motors, etc., where specifications covering the customer's specific requirements are compiled, and definite orders issued to the shops. Here hundreds of orders, each covering but a small number of completed units, may be in progress in the factory at any given time, yet each order must be dealt with on its merits, and completed by the date given to the customer before the order was secured.

It is to be feared that, before the advent of the Progress Department, the question of delivery was not treated in a scientific manner, owing to the fact that the Sales Department did not have the necessary data to work upon. The commercial man was keen upon securing the order, and the question of price being satisfactorily settled, he was prepared to promise anything by way of a delivery

date to ensure the order falling into his grasp. His initial success, however, hardly compensated him for the worry and trouble at a later date, consequent upon the inability of the factory to execute the order within the time promised. Correspondence ensued, and the exasperation of the customer was not appeased by the receipt of polite letters regretting the delay, etc., and definitely promising

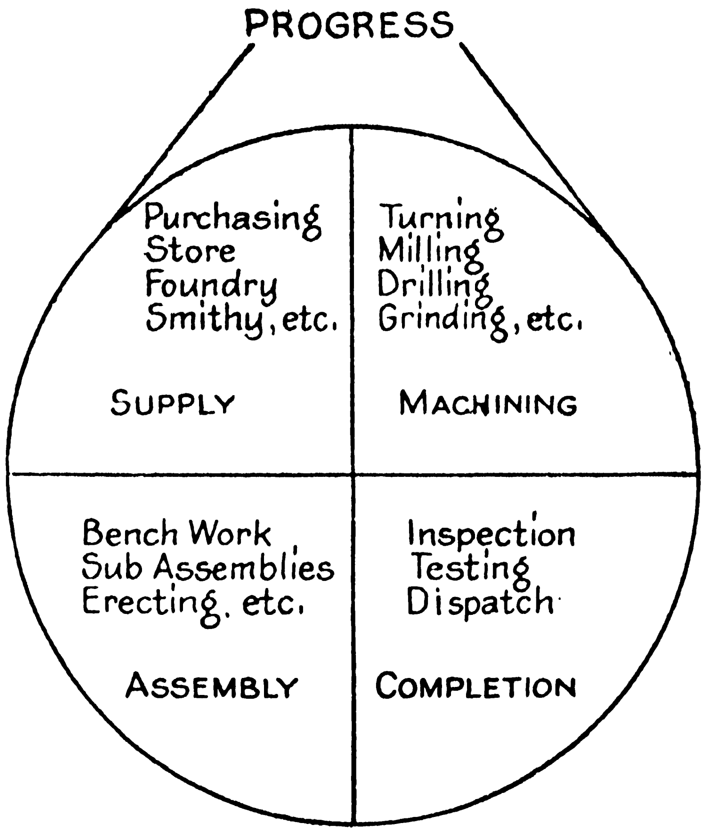


FIG. 19

THIS FIGURE SHOWS THE LIMITATION OF DEPARTMENTAL INTEREST IN ANY SPECIFIC ORDER AND DEMONSTRATES THE VALUE OF THE ALL-EMBRACING PROGRESS DEPARTMENT

to dispatch in ten days' time. The chances were that at the date the letter was written the order had not been put in hand in the shops, and therefore could not possibly be executed within the ten days promised.

The reputation of the firm suffered considerably when it failed to discharge its delivery obligations, and it cannot be expected that a customer will place a subsequent order with a firm whose unreliable delivery estimates have already caused him much inconvenience, and possibly expense. The commercial man is not wholly to blame—the fault is really due to the organization (or lack of it), for to the absence of co-operation between the commercial departments and the shops the trouble may be traced.

The establishment of an Estimating Department to furnish particulars regarding costs and delivery, for the purpose of securing a basis upon which to quote, does not obviate the difficulty in connection with delivery, the reason being that the calculations are purely theoretical, and the important factor of fluctuating shop conditions is entirely disregarded. Thus it is that, whilst the calculations prove that a certain type of unit should be quoted for, say, six weeks, it does not follow that the factory will be able to effect delivery in that time. Adverse factors arise which upset all theoretical calculations, the result being that the promise given to the customer fails to materialize.

The only practical alternative is the institution of the Progress Department, to which all inquiries respecting delivery (in regard to either prospective or actual orders) are referred. The following procedure in this connection has been adopted by certain large engineering firms, and the result has been most gratifying, inasmuch as complaints from customers on the score of belated deliveries have sensibly diminished, whilst business has shown a marked increase in volume.

The Progress Department is divided into sections, each dealing with a specific line of manufacture, and each section is controlled by a competent progress man, known as a section leader. This individual's responsibilities are two-fold, viz.: (*a*) to estimate delivery in connection with new business; and (*b*) to ensure the delivery of actual orders in accordance with the date given.

It is right and proper that the individual responsible for the estimate should carry it through to its logical conclusion, and that is why the measure of success is so much higher when the progress man assumes entire responsibility for delivery. It puts him on his mettle, for he dare not give a delivery estimate without due consideration, knowing, as he does, that should the inquiry develop into a definite order, he will be called upon to confirm his estimate by actual facts. His estimate is no mere guess work; it is based upon a profound knowledge of the circumstances governing shop conditions. As it may take a month for the inquiry to materialize into an order, he must know what conditions are likely to be prevailing at the time the order reaches the shops.

The Commercial Department, having received an inquiry, sends a form containing particulars of the customer's requirements to

the Engineering or Instructional Department. The engineer makes the calculations which determine the class of manufacture and the size or capacity; states whether it is of a standard, semi-standard, or special type; what constitutes the special features (if any); whether new patterns or dies are required, and the time necessary to get the complete specifications and instructions into the shops. The form is then sent to the Progress Department, and handed to the section leader responsible for the class of manufacture referred to. This individual considers the engineer's report with the conditions prevailing in the shops, and estimates for delivery accordingly. The form is then sent to the Estimating Department, for the cost estimates, and returned to the Commercial Department with the whole of the information necessary to enable that department to quote intelligently. (See Figs. 3 and 4, page 16.)

To give further expressions to this method of estimating deliveries, the following examples may be cited—

(1) The engineer's report shows that the customer's requirements will be met by the supply of a standard unit of a certain type, all parts for which can be taken from stock and assembled. Assembly sheets are all that is necessary by way of instructions, and these can be issued within three days. To the progress man this is a fairly simple proposition, although it must be borne in mind that in such circumstances a "cut" date is essential to secure the order. He must know what other orders covering a similar type of unit he has on hand, and whether there will be sufficient parts in stock to enable him to meet the estimate he is about to give. Assuming that at the present rate of progress there will not be sufficient parts available, he must know in what condition the missing parts are and when they are likely to be available. Then he must consider the amount of work likely to be on hand in the Assembly Department, and base his estimate accordingly.

(2) A standard unit can be used, subject to certain modifications being effected. Special instructions are necessary here, and the engineer estimates that one week will be wanted for the compiling of these. The progress man must consider the amount of work involved in carrying out the modifications suggested, and what effect this work will have upon the departments to which it will be entrusted.

(3) Although falling within the category of a certain type of

manufacture, the special features are such as to preclude a delivery estimate being based upon the same grounds as the foregoing. In the previous instances it is assumed that the structural pieces are standard; that castings and forgings (or at least the patterns and dies necessary for the production of these) are available. The modifications to a standard machine, as required in the second illustration, are confined to the special machining of small parts, special windings, or, may be, a casting not usually associated with that type of unit, but for which a pattern is already in existence. Here, however, the unit must be specially designed. A large number of standardized small parts can be used, but the structural parts are entirely special. Patterns must be made before the frame can be cast, special punching and stamping dies must be made, and it is evident that several weeks must be spent in the designing and the manufacture of the necessary tools before the actual productive work can be commenced.

The progress man here has a very delicate task to perform, for he is up against factors of unknown quantity, and the slightest miscalculation may cost him dear. In arriving at an estimated time, he must allow himself a safety margin to provide for unknown contingencies. This margin, however, must be within reasonable limits, otherwise the time given will be such as will effectually extinguish the firm's chances of securing the order.

The question of delivery was never so important as it is at the present time, and the estimates of the progress man are subjected to the critical scrutiny of the commercial man anxious to secure orders. The moment he finds that delivery is the predominant factor he challenges the progress man's estimate, and seeks to show that this could be materially improved. He does not hesitate upon such an occasion to state his case to the works manager, and the onus is then upon the progress man to prove that his estimate cannot be improved upon under existing conditions. He will be called upon to show by what calculation he arrived at his estimate, and in nine cases out of ten it will be in connection with shop conditions that he will be the more closely pressed. The commercial man does not concern himself with possible shop troubles. An apparently similar type of unit was accepted at five weeks' delivery in January of this year. Why should the factory now require seven weeks?

The progress man, as a business man, understands and appreciates the standpoint of the commercial man, though his knowledge of shop procedure and conditions convinces him that the demands of the Commercial Department are at the moment impracticable.

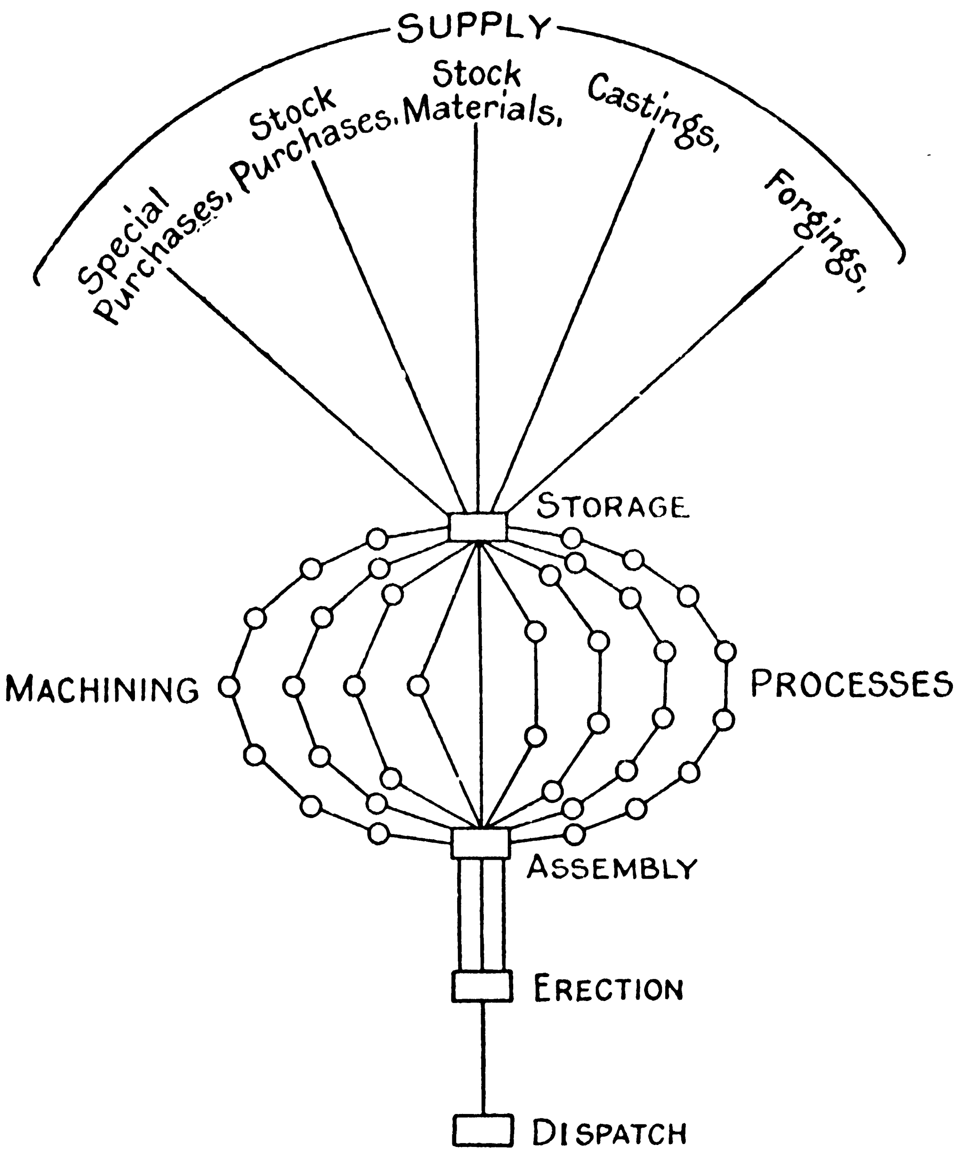


FIG. 20

THE PROGRESS MAN'S VIEW OF AN ORDER

As a business man, he recognizes that business is essential to the existence of the factory, and that the turning away of new orders (by quoting a prohibitive delivery) incurs grave responsibility. On the other hand, the acceptance of new orders upon a delivery quotation which is obviously impossible is a risky procedure, inasmuch as the result may be not only to damage his reputation in the eyes of the management, but also to impair seriously the reputation of the firm in the eyes of both present and prospective customers.

It will easily be seen that a delivery estimate involves a far greater amount of individual responsibility than does an estimate in connection with the price. With the latter, costs are standardized to such an extent as to bring the calculation into definite limits; but in regard to delivery, especially when the customer's special requirements are catered for, standardization cannot be applied to anything like the same extent. In the case of standard lines of manufacture produced upon a repetition basis, it is possible to work to a monthly schedule, although even this must at times be extended to meet the varying shop conditions.

The quotation having materialized into a definite order, the onus is upon the Progress Department to execute this in accordance with the promise made. It may be said that the progress man is not a producer, and cannot, therefore, be held responsible for the production of the article covered by the order. This, however, is precisely what is expected of him, and again his business ability, plus his intimate knowledge of shop procedure, must be brought into play. It must be understood that it is very rarely that one foreman deals entirely with the whole of the details required in connection with any specific order, and that, in such circumstances, the foreman is only responsible for any part whilst it is in his department.

As an example, an order covering a small A.C. electric motor may be given. The foundry foreman is responsible for the production of the castings, and once these have been handed to the machine shop he evinces no further interest in the fate of the order. The machine shop foreman's interest vanishes the moment the last machined part is handed to the assemblers, and the foreman assembler's when he passes the assembled cores to the winding department. The foreman of that department retains responsibility until the wound parts are safely out of his department, when he retires in favour of the erecting shop foreman, and so on. Then comes the test, and once the completed unit has passed this no further interest is evinced by the head of any productive department.

The progress man cannot shed his responsibilities so easily, for, from the time the order is received in the factory until it has been dispatched, it is under his control. He must know the time necessary for any part to pass through any department; not the theoretical time, but the actual time, taking into consideration the amount and class of work in the department, and the sequence

in which the work must be completed. It is safe to say that no other man has the same comprehensive knowledge, and the fact that the progress man himself has given the delivery estimate makes it imperative that he should extend himself in order to justify the calculations which produced the estimate.

The Progress Department links up the various manufacturing departments interested in the order, and creates an efficient organization which makes it possible to conduct business in a businesslike manner. The progress man is concerned with the order as a whole, no matter in what parts of the factory the details comprising that order may be, and it may safely be inferred that he imparts a business flavour into the factory, drawing the manufacturing and the commercial sections together, and making it possible for the firm to maintain a progressive policy. More business is secured, because the firm has the reputation of achieving what it has promised; and the Commercial Department in possession of reliable data can quote intelligently. The policy of the Progress Department, showing its relationship with the manufacturing departments, together with its system of record keeping, will be dealt with in the succeeding chapters.

CHAPTER XII

HOW THE PROGRESS DEPARTMENT ASSISTS PLANNING

THE Progress Department, in addition to introducing business methods into the factory and ensuring deliveries being kept, is closely associated with output. To the uninitiated, delivery and output are one and the same thing, but in reality each has a separate and distinct meaning. Delivery means the completion and dispatch of a definite order in accordance with a date previously agreed upon, whilst output is more or less associated with production upon repetition lines, where the article is turned out in bulk quantity, and afterwards placed upon the market as a standard line.

In some factories delivery *and* output are considered together, this particularly in connection with semi-standard lines of manufacture produced in fairly large quantities, yet with some slight variation to meet the needs of a specific customer. In cases of this description, a definite weekly output is aimed at, but the output of any one week must comprise the customer's orders due for completion during that week. It is not permissible to maintain output at the expense of delivery, and yet the management insist upon the output being maintained. In such circumstances, therefore, the progress man is oft-times in a quandary, for it frequently happens that on account of close application to the claims of delivery, the rival claims of output do not receive adequate attention. It is a most difficult position, which only the expert can negotiate with any possibility of success.

It is, however, in connection with output as apart from delivery that this chapter is concerned; that is, the production of a standard line of manufacture to be placed upon the market for distribution. Here a given number is predetermined as the output for the year, this number being charted and divided into definite weekly or monthly sections. It is sometimes asserted that the Progress Department has no place in the factory working under these conditions; that the factory is planned, and that output will follow automatically—but experience teaches otherwise. It is true that the planning section is well to the fore, but it is true also that the

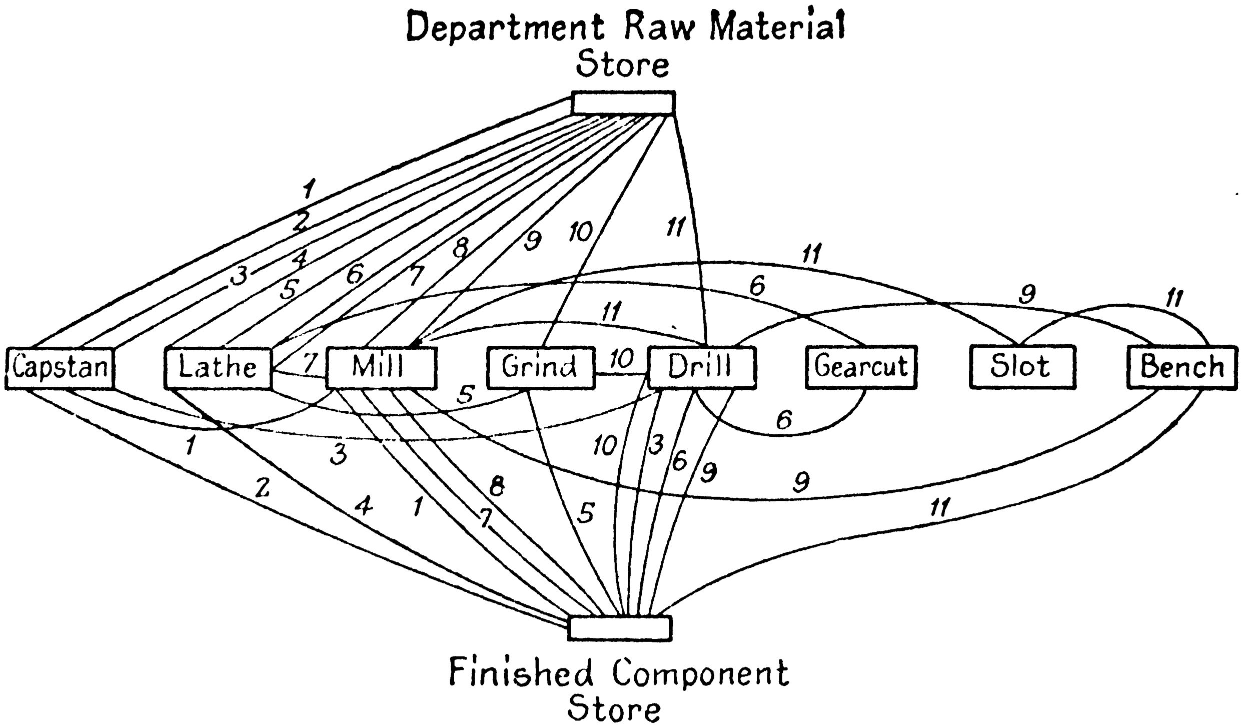
aims of the planning section can never materialize unless assisted by a strong progress organization. How valuable that assistance is, it is the object of this chapter to demonstrate, and the writer is certain he will be able to prove that an efficient Progress Department is as essential to the factory solely concerned with output, as to the factory dependent upon the prompt delivery of customers' special orders.

The factory with which this chapter is concerned is laid out to the best advantage for the production of the specific line of manufacture in which it is interested. The machine shop is divided into definite sections, care being taken to ensure that the capabilities of one section are commensurate with those of another. This, of course, is necessary, for assuming the weekly output from the factory to be 250 assembled units, it is obvious that 250 sets of details are wanted from each section weekly. Not all the details comprising an assembled unit pass through every section in the factory. One detail may pass from turning to milling, omitting the drilling section; whilst another may be completely machined in the capstan section, passing direct to the assembler. This must be taken into consideration when planning the shop lay-out, otherwise there is a probability of idle machines being in evidence in one or more sections. What are required from each section, therefore, are 250 sets of those details in which the section is interested, making it possible for the output of 250 assembled units from the factory to be maintained.

The routeing of the component parts, then, is a matter which must receive careful consideration, for it is here that the basis for successful production is formed. The planner, or the rate fixer, or whoever is deputed to carry out this duty, must work with a view to ensuring the maximum production from each and every section, and a combination of theoretical and practical experience is essential to the interests of economical production. The necessary tools, jigs and fixings must be likewise planned ahead, care being taken in this respect to ensure any tool, jig, etc., being ready by the time the operation for which it is intended is due to be put in hand.

The planning having been accomplished, the progress man is necessary to ensure that the results of that planning realize expectations. It must not be inferred by this that the Progress Department

is a subsidiary concern, but this aspect will be taken later. For the moment it is proposed to show how the department succeeds in exploiting the work of the planner, making it possible for the maximum results to be attained.



1. Capstan, Mill, Store.
2. " Store.
3. " Drill, Store.
4. Lathe, Store.
5. " Grind, Store.
6. " Gearcut, Drill, Store.
7. Lathe, Mill, Store.
8. Mill, Store.
9. " Bench, Drill, Store.
10. Grind, Drill, Store.
11. Drill, Mill, Slot, Bench, Store.

FIG. 21

MACHINING PROCESSES OF ELEVEN COMPONENTS COMPRISING ONE ASSEMBLY

Each factory has its own system of routeing, but in every instance it is designed in such a way as to allow the Progress Department adequate information. The whole of the details involved are set out in the form of a specification list, this giving particulars regarding quantity, size and class of material required, source of supply, etc. In some factories the routeing is embodied in the particulars given upon the specification list, whilst in others this information is conveyed by means of production cards. Whichever method is favoured, however, it is this information which determines the policy of the progress man, and enables him to know at the outset the departments and sections involved, and the time any part must spend in any one department or section.

The source of supply is a factor which must engage the attention of the progress man at a very early stage, for obviously, until the material is forthcoming, nothing can be done by way of manufacture. A perusal of the specification list will show that various parts must emanate from the foundry, smithy, material store, and outside firms, so that altogether a good deal of preliminary work must be accomplished before general manufacture can commence.

The work of the progress man commences long before the actual production stage, and he can materially hasten the time for the part to be put in hand. Once the detail drawing is in readiness the progress man can go ahead, for he can just as well bring pressure to bear in the Tool Designing Department and the Pattern Shop as in the Machining or Fitting Departments. Much trouble is occasioned in some factories owing to failure to observe this truism, it being popularly supposed that the Instructional and Tool Departments cannot be hurried. Whilst it is true that the *actual work* cannot be hurried, this applies to the Machining Department quite as much as to the Tool Designing Office. The progress man is not there for the purpose of hurrying the actual work, no matter where it may be, but his business *is* to obviate delay, and his services are as necessary in this respect to the Instructional Department as to any manufacturing department.

The Progress Department, then, is concerned with the prompt issue of instructions to the factory, and exerts its influence with a view to minimizing "idle time" which, obviously, is lost time. Certain instructions are promised in three weeks, but the actual time taken for preparing these instructions is perhaps one week, the other two weeks being "allowed," owing to the volume of other work which must precede this particular job. This may be unavoidable, but then again some of it may not be so, and it is the "avoidable" idle time which engages the attention of the progress man in each and every department.

The pattern drawings having been prepared, the making of the patterns must, of course, precede the castings of the article, time must be spent in constructing the wood pattern, and then, in all probability, iron working patterns are required. On a new line of manufacture this work is more or less experimental, and many alterations and adjustments may be necessary ere the patterns are finally approved. Planning alone will not guard against every

contingency which may arise, and to ensure success in this direction efficient progress work is necessary.

Patterns being made, the foundry can start delivering the goods, and so one source of supply is open. The making of tools, dies and templets precedes the production of forgings, stampings, and pressings, the same procedure being followed by the progress man as in the case of patterns. The association of the progress man with the Tool and Pattern Departments has already been discussed in detail, and further comments are therefore unnecessary.

The question of the outside firm as a source of supply falls within two categories, each of which requires different handling. In one case, raw material for finishing in the factory is the consideration, whilst, in the other, the outside firm supplies the finished product.

OUTSIDE PURCHASES

Order No.......................... Type of Apparatus..

Due for Delivery ....

Rough					Finished				
Quan.	Drawing	No.	Name of Part	Recd.	Quan.	Drawing	No.	Name of Part	Recd.

Fig. 22

It is obvious that the first named must receive primary attention, as in all probability operations occupying several weeks are necessary before the piece for which the material is required is ready for the assembler. The progress man must, therefore, keep in close touch with the Buying Department, with a view to getting into the factory first such material as will require the greater amount of time spent upon it.

The material store as a source of supply is a much simpler

proposition, for with an efficient store organization adequate supplies of material are available, and this can be drawn upon as required. It will thus be seen that the Progress Department must differentiate between the various sources of supply, and so ensure the availability of the material in accordance with requirements. Having settled this satisfactorily, the processes through which the part has to pass in the factory must be considered.

Much depends now upon the line of manufacture being produced. If the completed unit is comprised of but a single assembly, the progress of the parts through the shops is a comparatively simple matter; but where a number of sub-assemblies are involved, these in their turn having to be assembled together to form the completed unit, a more intricate state of affairs exists. The manufacture of motor chassis forms an excellent illustration in this respect, and the parts must be progressed through all stages to meet the requirements of the specific sub-assembly of which they form part.

The processes through which each part has to pass are decided upon by the Rate Fixing Department, and the duty of the progress man is to see that no time is lost in getting the parts through the various operations. One part may get through the machine shop with but two operations, whereas, in the case of another, a dozen operations are necessary. Yet these two parts are required by the assembler at precisely the same time, and it is apparent, therefore, that the progress man must exercise judgment. It is here that the Progress Department must plan, for haphazard chasing is of no avail. With thousands of component parts in process, it requires some skill to determine the order of procedure, and the most elaborately designed programme cannot ensure every part coming through in the exact order required, unless assisted by the personal attentions of the progress man.

It will be observed that the structural parts of the unit are usually castings or forgings, and as also these parts in the main must be subjected to a number of long machining operations, it is in this direction that the activities of the progress man must extend in the first instance. A chart is compiled showing the numbers of each part due from the foundry or smithy each week, this being checked by the actual output per week from either of these departments. It must be borne in mind that output from the foundry is often reckoned in weight, and the tendency on the

part of the foundry foreman is, therefore, to produce those castings which will the most easily reach the weight aimed at. The progress man (and the factory generally) is concerned with *sets* of parts (these including a goodly number of small details), seeing that these are necessary to ensure the output from the factory, and his business

WEEKLY CASTINGS LIST

Type of Apparatus ....

Order or Batch No........................ Number of Sets Due..................................

Week Ending...

Quantity Due	Pattern No.	Name of Part	Number Delivered (to be entered by Foundry Foreman)

FIG. 23

is to see that sufficient sets of parts are produced by each and every department to enable the factory to produce a given number of assembled units each week.

The Progress Department is the production regulator. Left alone, the output from a certain department will assume gigantic proportions, but output under such conditions is a liability rather than an asset to the firm. The quantity is there, but it is unmatched, and as a consequence the assemblers cannot produce the completed unit on account of missing parts. The systematic progress of parts through the shops, with due regard to the degree of urgency, based upon the relative value of each part from an assembling standpoint, is a matter of vital importance. The prosperity of the factory is determined by the output of assembled units, and not by a huge mass of detail, the greater portion of which must of necessity remain idle in the store for a considerable period.

Administration must be active, not passive. It must be ahead of production—a fact that is frequently lost sight of. And it is the Progress Department that carries the emblem of activity, for it cannot remain passive. It opens up possibilities and forces the interested parties to exploit them. It facilitates production at every stage, and makes it possible to produce three where in the past but two were produced. It takes outside worries away from the foreman, enabling him to devote his energies entirely to economical production, and this being so, it evolves a progressive Planning Department. It encourages team work, but it does not destroy individuality, and that is the secret of its success.

Intelligent co-operation is efficient organization. Initiative is necessary to ensure success. The football team works collectively, yet each individual is liable to be tested. There are times when everything depends upon one individual, and if he fails the combination is smashed. The team is comprised of intelligent individuals, each alive to his own importance, yet never letting that fact blind him to the importance of the other individuals comprising the combination. It may further be observed that each man is selected for his proficiency in one specific direction, and it is very rarely that one individual can achieve the same measure of success in more than one position. It is not always possible to determine at the outset the right position for any man, but he must be persevered with until the right place is found. And as in the football team, so also in the factory.

CHAPTER XIII

THE PROGRESS DEPARTMENT STATISTICS

THE statistical side of the Progress Department has received much attention of late, for the value of records compiled from authentic sources has come to be appreciated. A vast amount of valuable information, which in the past has been allowed to go astray, is now set upon permanent records, and as a result many seemingly inexplicable occurrences have been satisfactorily explained. Thus it is that records compiled in the Progress Department are looked upon as valuable data, and the development of this side of the department's activities has been (and is being) encouraged to perhaps a greater extent than any other branch.

It is right that every encouragement should be given here, but it must be borne in mind that the development of every branch of the department's activities must be proportionate, and as the records are compiled from "information derived" it is essential that that information is reliable. Assuming that the department is efficient in all branches, however, the records are such as will give the whole and complete history of every order—of every detail in connection with every order. Further, the records are contemporary with the job, so that the history is complete to the hour it is called for.

The aim of this chapter is to demonstrate the value of statistics when completed, and the effect these have upon the policy of the management. The charts, graphs, tables, and the like give the bald facts, but details obviously cannot be shown. The chart may show that, whereas the estimated output by a certain date is 200, the actual output figure is 130, but it does not give the reason. Some ingenious charts go farther, and show the very department which is behind the estimate, but even here full details are necessarily lacking, and other records must be consulted in order to arrive at the true state of affairs.

Because the figures of the main output chart are against a certain department, it does not follow that this department is wholly and solely to blame, and so the whole question must be probed

in order to get at the real facts. The record, however, is not compiled merely to clear a department of charges brought against it, but to show the real root of the trouble, so that the necessary steps may be taken to prevent a recurrence.

When an order is received in the Progress Department, the fact is duly recorded, and this first record is of vital importance. In the first place it gives the quantity of pieces on order, the type of apparatus, the time necessary for the issue of working instructions, and the delivery date. Subsequently additions are made to the record, and the progress man can inform the management at any time: (1) the number of orders received during any given period; (2) the number of any specific type or size of unit for which orders have been received; (3) the percentage of delay in the issue of working instructions during any given period; and (4) the variation (if any) in the delivery dates for a similar class of unit.

Further, the progress man can state precisely, at any time, the total number of orders for which working instructions have not been issued; the total number of orders actually in progress, and what type or size of unit they cover. All this information is derived from a record, the compiling of which occupies but a few minutes daily.

The records bearing upon any one specific order may take the form of progress sheets or history cards. To take the last-named first, this gives, in an abbreviated form, particulars of everything of importance which is likely to have an effect upon delivery. The history card, bearing the order number, will record substantially the particulars given in the first record so far as they affect the specific order, and these are added to as time goes on. So from the history card one may learn that the order, covering a certain type of unit, was received in the Progress Department on 17th July; that the working instructions were due on 24th July, but were not actually received until 27th July; that the delivery date was 21st August, but that the order was not cleared until 31st August; whilst it may also show a revised delivery date, e.g. 28th August, which was not adhered to.

The history card now must show why it was necessary to revise the delivery date, and also why it was that the revised date could not be met. When once a delivery date is given, this cannot be extended without very good reason, and it is assumed that the

PROGRESS OFFICE RECORD OF ORDERS RECEIVED

Date	Sales Order No.	Works Order No.	Quantity on Order (and Type)					Delivery	Instructions		Work in Progress
			Type A	Type B	Type C	Type D	Type E		Due	Received	
5/9/..	351–17	D 846				4		6 weeks	12/9/..	13/9/..	14/9/..
6/9	370–17	B 852		3				4 ,,	9/9	9/9	9/9

Fig. 24

HISTORY CARD

Works Order No.........*537*............ Sales Order No.........*14/17*............ Quan.........*4*........... Type...........*X Motors*...........

Working Instructions Due } ....*24/7/*........ Working Instructions Received } ....*27/7/*........ Delivery Date } ....*21/8/*........ Revised Dates *28/8* | *31/8* | Dispatched....*31/8/*........

27/7/.	Advised Sales that Working Instructions just received, and delivery must be extended till 28/8.
29/7	Sales replied accepting revised delivery date.
21/8	Letter from Sales asking if date (28/8) will be kept. Replied O.K.
26/8	Shops advise Unit failed on test and returned to erecting. Promised back to test 28/8.
26/8	Advised Sales *re* above, and revised delivery to 31/8/...
31/8	Unit dispatched.

Fig. 25

original date, viz. 21st August, was given on the authority of the Progress Department, or taken from a delivery schedule for which the Progress Department admitted responsibility. This being so, the date could not be altered with impunity, and the onus there is upon the Progress Department to show cause why the date could not be met. From our history card we may elicit the following information.

The failure of the Drawing Office (or the Rate Fixing Department, whichever was responsible) to issue working instructions to time materially affected the planned arrangements of the progress man, and although only two days' delay was occasioned, it was necesary to put the delivery date back one week. The Commercial Department was notified accordingly, and the revised date accepted. On 28th July, the Progress Department instructions in regard to dates, etc., were issued to the shops, and the next entry on the history card, dated 21st August, shows that an inquiry regarding delivery had been received from the Commercial Department, and that a reply had been sent to the effect that the revised delivery date, viz. 28th August, would be adhered to. Up to this time there was no entry upon the card bearing on the progress of the parts through the shops, this suggesting that satisfactory progress was being maintained. On 26th August, however (two days before the revised delivery date), it is recorded that the unit failed on test, this necessitating its return to the assembling shop. The delivery date then could not possibly be met, and so the Commercial Department was advised and a new date (31st August) given. These facts were duly recorded, and the last entry shows that the unit actually left the factory on 31st August, the last date given.

The progress sheet is an even more comprehensive record as, from the time the order is placed in the shops until the last detail has passed through the Despatch Department, every incident of note is published. The troubles experienced in this department and that department are clearly set forth, and the time taken on any specific detail in any section will (if excessive) be recorded. Thus it can be seen at a glance that a certain casting, due to the machine shop by a certain date, arrived there ten days later, and that as a consequence a certain part of the unit was delayed, this affecting the final delivery date. Also another detail, ordered from an outside firm and promised for delivery by 12th August, was not

received until 20th August, that the part was urged on 13th August and again on 17th August, and that the firm had replied giving reason of delay and offering a revised delivery date.

Any lapse on the part of the progress man is also shown, for it must be remembered that only true statements can be recorded,

PROGRESS SHEET

Quantity........*12*........ Type....*X-Special*.... Description....*Sub-standard Motors*
Delivery due ....*29th August*.................... Revised................ —— ....
Order No.....*1234*.... Sales No.....*DB361*.... Customer's Name....*J. Blank, Ltd.*

The Stator	The Rotor	Special Details	Special Parts to be Machined
Core Assembly Standard	*Core Assembly Standard*	(*a*) *From Foundry 10th August*	(*a*) *By 20th August Casting not received from foundry until 20th Aug. Job rushed—completed 24th Aug.*
		(*b*) *From Smithy 4th August*	(*b*) *By 20th August Completed 17th August*
Winding Standard	*Winding Standard*	(*c*) *From Outside 12th August*	(*c*) *Progressed 10/8, 13/8, 17/8. Promised 21/8, received 23/8*

Erection	Testing	Dispatch
By 24th August *Shortage of casting—holding up 21st August* *Received 24th August* *Completed 26th August*	*By 25th Aug.* *Unit not received until 26th August* *Completed 26th August*	*26th August* *Dispatched 27th August*

FIG. 26

seeing that, in the event of an inquiry, any item is liable to be challenged by interested parties. Each statement must be borne out by documentary evidence, and woe betide any progress man who cannot support what he has recorded. If a delay has been occasioned by a congestion of work in a certain section this is shown upon the progress sheet, but the fact that a delay has occurred for which no explanation is forthcoming suggests that the progress man is at fault, and action is taken accordingly. It is a very difficult thing for the progress man to shelter himself behind either real or imaginary delinquencies of other people, for any attempt in this

direction invariably recoils, and he stands condemned by his own records.

From the progress sheet many valuable condensed reports may be compiled, and amongst these may be mentioned the monthly delivery analysis in connection with orders for specific customers. This, in the first instance, is derived from the record first mentioned in this chapter, and is supplemented by the particulars given upon the progress sheet. Thus, the works manager may know that 60 per cent of the orders were delivered to time, and that certain percentages were one, two, or three days late. He also knows that 5 per cent were over one week late, and that 5 per cent represented two customers' orders. Naturally, he desires to know why these orders were late, and the detailed information is readily furnished by a perusal of the progress sheet.

The records so far referred to are used principally in the factory which deals with orders for parts manufactured for specific customers, but in the repetition factory the progress records are no less valuable. One important record here is the Detail Progress

DETAIL PROGRESS SHEET

Name of Part	Drawing No.	No. Per Set	Material	Batch No.				Batch No.				Batch No.				Batch No.			
				101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
				20	20	20													
Crank .	238	1	C.I.	20	20														
				20	20														
Crank Pin .	239	1	M.S.	20	20														
				20															
Gear .	240	1	M.S.																

First Line: Number Received. (*Enter in Black.*)
Second Line: Number in Process. (*Enter in Red.*)

FIG. 27

Chart, which shows at a glance the total amount of raw material received for each and every detail, what proportion of that material has been appropriated and put into process, and the amount of material still available as being unappropriated. This chart is compiled from delivery notes, and is amended daily.

In the factory it is essential that the whereabouts of any batch of components is known at any time, and this is possible by the use

WORK IN PROGRESS

Order No........................ Quantity........................ Drawing No........................

Name of Part..

Received from Store	Operations	Quan.	Date	Sig.	Operations	Quan.	Date	Sig.
Castings	*Bore*				*Drill*			
Stampings	*Mill*				*Gear Cut*			
Forgings	*Plane*				*Tap*			
Bar Material	*Shape*				*Grind*			
	Turn				*Broach*			

Rec. in Finished Store..

Signature.

FIG. 28

of progress record cards, whilst, in order to keep each section fully employed, the amount of work expected into any one section should be ascertainable. For example, the foreman of the drilling section knows what is already in his section, how much of that work is actually in hand, and how long he can carry on without further work arriving. Being a far-seeing man, however, he desires to know what are the prospects a few weeks ahead, in order to plan his production, and so he solicits the aid of the progress man.

The information he desires is readily available, for in the Progress Office are tables showing: (1) The total number of orders undergoing process in the section immediately preceding the drilling, i.e. 250 articles to a certain drawing now turning—250 to another drawing now milling—both lots to come to the drilling section for

WORK EXPECTED INTO DEPARTMENT

Drawing	Name	Turning				Milling				Drilling				Slotting				Bench Fitters				Assemblers			
1001	Bracket . .	(1) ~~250~~	(1) ~~250~~							(2) ~~250~~	(2) 250			(4) 250	(4) 250			(3) ~~250~~	(3) 250			(5) 250	(5) 250		
1002	Cap . . .	(1) ~~250~~	(1) 250			(2) ~~250~~	(2) 250											(3) ~~250~~	(3) 250						
1003	Shaft . . .	(1) 250								(2) 250												(3) 250			
1004	Collar . . .	(1) 250																				(2) 250			
1005	Spindle . .	(1) 250												(2) 250								(3) 250			

Strike out operations already completed.

FIG. 29

the next process. (2) The total number of orders which are two operations away, e.g. now turning, to be milled and then drilled. (3) The total number of orders three operations away, and so on. The drilling foreman can thus see what prospects he has for future work, and is able to make the necessary arrangements.

Records showing the amount of scrap work are, in many instances, compiled by the progress man from individual inspectors' reports, and these show: (1) The name of the part. (2) The section or department responsible. (3) The individual responsible. (4) The steps taken to prevent a recurrence, etc. It is possible by these

WORK REJECTED

(*Taken from Inspectors' Reports*)

....Department.

Date	Report No.	Quan.	Drawing	Name of Part	Operator

FIG. 30

records to determine to some extent the value of the foreman as a department manager, and the value of the operator as a workman, as obviously an abnormal amount of scrapped work must reflect upon the capabilities of both the foreman and the operator. The Progress Department, of course, does not make a decision. It merely produces evidence of a strictly impartial character.

The records of the Progress Department have an important influence upon the policy of the management. The compilation of delivery schedules is governed very largely by these records, for they show whether or not it is possible to deliver a certain class of apparatus in a certain time. The progress sheet, in particular, is a true index of the conditions prevailing in the shop, and these conditions materially affect deliveries. The progress record tells the management whether the shop is crowded or slack; if orders can be taken on a long or a short delivery; the particular type or size of unit to accept or reject; and many other things of a like character. With such records at his disposal, the works manager does not need to *ask* his foremen, but on the contrary he is in a position to *tell* them facts.

CHAPTER XIV

THE PROGRESS OFFICE

THE actual Progress Office organization is to a very large extent dependent upon the general principles laid down for manufacture, and as, in the majority of factories, this office is a comparatively recent acquisition, it cannot run directly counter to established procedure. The factory organizer rarely finds a definite Progress Office established—there is a progress system, of a sort, spreading throughout the factory, and one of the first acts of the organizer is to consolidate his forces by the establishment of a Progress Office.

The creation of this office is not strictly a change of system—rather it is a strengthening process, and it does not necessarily follow that a brand new staff must be imported to carry out the new duties. Some additions are undoubtedly necessary and are also desirable, for new blood is essential for the speeding up which must inevitably follow. "Old hands," left to their own devices for so long, have got into a rut, and they are not easily drawn out. Example being better than precept, the importation of a few energetic young fellows from outside will work wonders, for these latter are soon on their mettle, seeking to justify their selection, and the older hands, contemptuous at first, are soon determined to show the "upstarts" that they, too, know something of the game, and exert themselves in order to prove it.

In no two factories is the composition of the Progress Office the same, for the duties of the personnel are very diverse, according to the product manufactured, the principle governing manufacture, and the views of the management concerning the responsibilities which should be undertaken by this office. This latter factor is very formidable and cannot very well be discussed in detail here, so, for the purposes of illustration, it is proposed to take two types of factory, and examine briefly the composition of the Progress Office, it being assumed that the management entertains the highest regard for its importance.

The Progress Office in the large factory engaged in many and various lines of manufacture is closely associated with the older

administrative departments such as the Store and the Buying Department. Each of these departments has a separate head, but the whole are controlled by one man—the Progress Manager. Thus, whilst the internal workings of each are separate and distinct, no one department exercising authority over the other, they are all dominated by a common policy. It really means that the factory system is divided into two parts—manufacturing and administrative—the supreme head of each part being of precisely the same standing, each being directly responsible to the works manager.

This chapter is, however, concerned with the inner workings of the Progress Office—the Store and Buying Department being dealt with later—and, as the actual duties of the progress man are well understood, we may consider the facilities he has for carrying these out in an efficient manner.

There are two sides of the Progress Office—the general and the sectional. The first may be termed clerical, and the second technical. We have dealt with the delivery estimates in connection with prospective orders, and now the system starts with the receipt of a definite order. This is received from the Commercial Department and handled by a record clerk whose first duty is to allocate a works order number. A series of such numbers is reserved for each line of manufacture, each having a prefix letter, thus, A 1-5000 Switchgear; B 5001-10,000, Controllers, and so on. When this number has been given a card record is compiled, this giving but brief particulars, and the other is then sent to the section progress man responsible.

The section man then takes up the running by recording the receipt as described in the previous chapter. It must be remembered that the section man is concerned only with the product in which he is interested, whereas the record clerk is concerned with every order received. Thus, the section man compiles and holds such records as affect his own work and to which he must constantly refer, but all records of general interest must be kept by the record clerk.

To put it another way, it should be possible for the head progress man to get particulars concerning any job even in the absence of the section man. A tribute was paid to one firm during the war by a representative of the Ministry of Munitions, who called at the factory during the lunch hour when all save the head progress

man were absent. In spite of the inopportune hour, the Ministry's representative was able to obtain the whole of the information required, the general matter being taken from the record cabinet, and the detail matter from the section man's records, which were easily accessible.

This, in a very large office, was no small tribute to the efficiency of the organization, for it was impossible for the chief to be personally acquainted with the latest developments of every order. For this to be effective it is necessary that many records be duplicated. Two copies of every letter sent to the department are placed on file—one by the section man and one by the record clerk.

The official order is held on file pending the arrival of the specification list, although it should be noted that, in the event of new drawings for any part being issued, a blue print or a photostat

REMINDER

TO SPECIFICATION DEPT. (DRAWING OFFICE) Date.................................

FROM PROGRESS OFFICE.

Please note that Complete Instructions in connection with the undermentioned orders have not been received.

YOUR IMMEDIATE ATTENTION IS REQUESTED.

Order No.	Covering	Instructions due	Remarks

Signed..

FIG. 31

copy should be received in the Progress Office, this being date stamped and initialed by the progress man concerned. Should the specification list not be received by the date promised, a reminder is sent to the Drawing Office, and if the delay is likely to

have an effect upon the delivery date of the order, the Commercial Department is notified and a revised date given.

Upon receipt of the specification list, the completion dates are issued to the manufacturing departments, and a form received from the Rate Fixing Department shows that the details are routed and the necessary work cards issued. A progress sheet covering essential details is compiled, this being handed to the progress chaser attached to the section. Charts and tables are drawn up, and the order may now be considered on the active list.

Information regarding the progress of the order through the manufacturing departments is received in the Progress Office every few hours, by means of delivery notes, delay notes, and reports from the foreman and chasers, this information being recorded upon the history card, or in some other manner. Correspondence concerning the order is received in the first instance by

WORK DELIVERY NOTE

From.................................... To.................................... Date..................................

Quantity	Drawing	Name of Part	Process Completed

Received..

Send copy to PROGRESS OFFICE.

FIG. 32

the chief progress man, and passed over to the section man responsible (via the records section). Letters, etc., sent to the shops from the Progress Office are addressed to the chasers or the heads of departments (according to which are affected) and signed by the section man, but letters or reports to the Commercial Department or the works manager bear, in addition to the signature of the section man, the signature of the chief progress man.

Where the practice is to hold a weekly foreman's conference, this is always attended by the chief progress man, who has with him the section man interested in the class of work under discussion. It is most important that the Progress Department is represented here, and particularly when a revision of programme is contemplated. A report of the meeting is afterwards circulated amongst the interested parties, and any statements made are subsequently placed on record. This may be said to describe briefly the routine of the Progress Office in the large factory, and the closer association with the manufacturing departments will be dealt with in the chapter under the heading of Progress Chasing.

CHAPTER XV

PROGRESS ROUTINE IN THE SMALL FACTORY

IN the smaller factory the routine of the Progress Office is more condensed than in the larger concern, for here the volume of work is not so great, and as a consequence individuals undertake the duties which in the larger office are divided into definite sections. In the factory about to be described but one class of work is manufactured, and although the details involved are many, they are more easily handled.

The general factory organization is less elaborate than that already described, for, there being but one class of work to be handled, although, mayhap, this be in various sizes and models, most of the preliminary work, such as drawings, tools, and the like, has already been done. The Rate Fixing Department is represented by one man, who is engaged upon adjustments and re-arrangements of processes and times, and who furnishes the Progress Office with records of the changes made.

A record of all processes and time allowances is kept in the Progress Office, and orders, in the form of operation work cards, are issued as required. The output of each size of unit is predetermined, and definite quantities of details are placed upon the shops in form of batches. That is to say, assuming that the unit is manufactured in six different sizes, and 1000 of each represent the yearly output, a batch covering 120 sets of details is placed on the shops each week, allowing 50 weeks to the year.

A set of cards constitutes the raw material record, and instructions for the issue of initial orders emanate from the clerk in charge of these records, who works from the weekly programme chart. At the same time the clerk shows on the card the amount of material appropriated, together with the amount still available, and immediately this latter figure reaches the ordering point a notification is sent to the Buying Section.

The list of initial orders to be issued is sent by the clerk in charge of records referred to in the previous paragraph to the progress clerk, who makes out the first operation work card for each separate

TIME AND PROGRESS CARD

Drawing No.................................... Name of Part...

PROCESS Tool No.				PROCESS Tool No.				PROCESS Tool No.				PROCESS Tool No.			
Time (Minutes each)				Time (Minutes each)				Time (Minutes each)				Time (Minutes each)			
Order No.	QUANTITY			Order No.	QUANTITY			Order No.	QUANTITY			Order No.	QUANTITY		
	On Order	Rej.	Comp.		On Order	Rej.	Comp.		On Order	Rej.	Comp.		On Order	Rej.	Comp.

FIG. 33

No.................... Name.. Min. Stock...................................... Card No...................

Date	Purchasing		Patterns or B. Ps.			Delivery			Balance Outstanding		Inspector's Report		Receipts			Receipts					Issues for Process			Issues for Process			Issues for Process		
	Quan.	Supplier	App. for	Sent	Retd.	Asked for	Speed up	Prom.	Quan.	Quan.	No.	No.	Date	Quan.	Total	Date	Quan.	Total			Date	Quan.	Total	Date	Quan.	Total	Date	Quan.	Total

(*Front*)

No.................... Name.. Min. Stock...................................... Card No...................

Date	Purchasing (continued)		Delivery (continued)			Balance Outstanding (continued)		Finished Stock			Finished Stock			Finished Stock			Issues			Issues			Issues			Issues				
	Quan.	Supplier	Asked for	Speed up	Prom.	Quan.	Quan.	Date	Quan.	Total	Date	Quan.	Total	Date	Quan.	Total	W.J.O.	Quan.	Total	W.J.O.	Quan.	Total	W.J.O.	Quan.	Total	W.J.O.	Quan.	Total		

(*Back*)

FIG. 34

A COMPREHENSIVE STOCK RECORD CARD, USED IN CONJUNCTION WITH THE TIME AND PROGRESS CARD (FIG. 33)

drawing number, showing thereon the time allowed, and also the tools, jigs, etc., necessary for the operation. These work cards are placed on file under the heading of the operation—all turning

PROGRAMME

ORDERS TO BE ISSUED

To Ensure an Output of 100 Units Per Week
TYPE Z UNITS

Name of Part	Drawing	Week Ending				Week Ending				Week Ending				Week Ending			
		19/2	26/2	5/3	12/3	19/3	26/3	2/4	9/4	16/4	23/4	30/4	7/5	14/5	21/5	28/5	4/6
Bearing .	1370		500				500				500				500		
Spring Holder	1371			1000								1000					
Frame . .	1372	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bracket. .	1373		200		200		200		200		200		200		200		200

Orders placed to cover Economical Quantities.

Fig. 35

under one heading; all press work under another, etc.—and a slip, showing briefly the particulars of the operation, is sent to the foreman concerned. It must be borne in mind that no work card

MATERIAL AVAILABLE

Dept.. Drawing..

Fac. No.	Quantity	Operation and Name of Part

To Progress Office.
Please issue above order for
Operator.. No.........................
Date.. Foreman..
Issued by ....
(*Progress Office*)

Fig. 36

can be made out unless sufficient material is available to do the job, for if material is not available the raw material clerk withholds the instruction to issue until such time as the material is received.

The receipt of the slip advises the foreman that the work can be put in hand, and when he decides to do this he returns the slip to the Progress Office and receives in exchange the process work card. This, it should be said, is made out in duplicate, the copy being sent to the store when the original is given to the foreman, so that the material can be supplied upon demand. When the material has been issued the duplicate is returned to the Progress Office, and the order is then entered upon a progress record card, this showing all work actually in operation.

When the operation has been completed, the work (with the card) is sent to the inspector, and passed by him into the process store. The storekeeper retains the material, signs the work card, and sends the latter to the Progress Office. Its return is duly noted on the progress record card, and the work card for the next operation is made out, this being filed as previously explained, and the foreman notified by means of a slip. This foreman in due course returns his slip, and receives in exchange his work card, and this procedure is carried out until the last operation is completed, when the parts are received into stock, and the progress record card marked "complete."

The return of the last process work card to the Progress Office denotes that the details enumerated thereon have been accepted into stock, and this information is duly noted upon a finished component stock card. So far, then, the Progress Office records consist of: (*a*) process and time cards; (*b*) raw material record cards; (*c*) progress record cards; and (*d*) finished component record cards. It does not necessarily follow that four different sets of cards must be used, for it is possible to effect a combination so that two different sets are sufficient for the four records, the services of two clerks only being required.

The sets marked (*a*) and (*c*) can be combined in the manner illustrated, for the progress record card (*c*) must show the sequence of the operations, and it is only necessary, therefore, to add the time allowance. In regard to the remaining records (*b*) and (*d*), these also can be shown on one card, and when this is done a most comprehensive record is compiled. The illustration shows: (1) the amount of raw material on order; (2) the date and amount received; (3) the amount of raw material in stock; (4) the amount of material put into process; (5) the number of finished components

in stock; and (6) the number of finished components appropriated for assembling shop orders.

The Progress Office has so far handled the component parts, and now the assembling of these parts must be considered. These are assembled in batches covering an economical quantity, and each order to the assembling shop is represented by an assembling sheet, a copy of which is sent to the store. A master assembling sheet is kept on file by the clerk responsible for the finished components record, and this individual shows on the card the quantity of every part appropriated.

In order to determine quickly what assembling orders can be placed, a chart showing the quantity available of each detail comprising the assembly is compiled. It may be that twenty or more details are used in connection with one assembly, and it would necessarily be a slow process for the progress man to scrutinize every record card before placing an order. As the completed work cards are received, therefore, a record is made, not only on the finished component card, but also upon the detail chart, this being done by the clerk responsible for the card record.

This chart tells the progress man at a glance exactly how many sets of details are available for the assembler, and therefore what further assembling orders can be placed. The progress man appropriates in the manner shown in the illustration, and this information enables the clerk to make the necessary adjustments on the card.

Work cards are made out only for such processes as are recognized, and the clerk does not issue orders upon the representation of a foreman or charge-hand if such a process does not appear upon the standard record. It sometimes happens that, for some reasons, an extra process is needed in connection with the details of one batch, this being due, perhaps, to defective material. When such a thing does happen, the authority for the issue of a special process work card emanates from the Inspection Department, together with the particulars relating to the reason why.

In like manner, also, no alteration to the time allowance is permitted, except upon receipt of written instructions from the rate fixer. Unforeseen circumstances may necessitate extra time being given upon a certain work card, and the foreman attaches a recommendation for this to his process card. This must, however, be confirmed by the rate fixer before it can be added to the card, and

ASSEMBLY OF PARTS (AND APPROPRIATIONS)

TYPE Z UNIT

Number of Sets.		1490	1500	1520	1540	1560	1580	1600	1620	1640	1660	1680	1700	1720
		Order Nos.												
Drawing No.	Name of Part.	8424 7 8425 3 8425 10	8425 4 8390 10	8391 10 8392 10	8393 10 9079 943 10	9242 10 9243 10	9261 10 9262 10	9263 10 9264 10	9265 10 9266 10	9329 10 9330 10	9331 10 9352 10	9774 10 9777 10	9778 10 9775 10	9776 10 451 10
1721	Bracket . .	$\cancel{20}$	$\cancel{20}^{10}$	20	$\cancel{20}^{11}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	20	20	$\cancel{20}^{10}$	$\cancel{20}$	$\cancel{20}$
1722	Gear . .	$3 + {}^{17}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	20	20	20	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}^{10}$	$\cancel{20}$
1723	Crank . .	$10 + {}^{10}$	$\cancel{20}^{4}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	—	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$
1724	Crank Pin .	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	20
1725	Frame . .	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	20
1726	Collar . .	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	20
1727	Spring . .	$7 + {}^{13}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20} + {}^{11} + {}^{9}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}^{10} + {}^{10}$	$\cancel{20}^{10}$	20
1728	Spring holder .	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	20	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	$\cancel{20}$	20
1729	Nut $\frac{1}{2}''$ . .	$\cancel{20}$	—	—	—	—	—	—	—	—	—	—	—	20
1730	Nut $\frac{5}{8}''$ . .	20	—	—	—	—	—	—	—	—	—	—	—	—
1731	Washer . .	60	$\cancel{20}^{10}$	20	$\cancel{20}^{11}$	20	20	20	20	20	20	$\cancel{20}^{10}$	$\cancel{20}^{10}$	20
1732	Pin $1'' \times \frac{1}{4}''$.	$10 + {}^{10}$	4	—	—	—	—	—	—	—	—	—	20	20
1733	Pin $\frac{3}{4}'' \times \frac{1}{8}''$.	20	20	20	20	20	20	20	20	20	20	20	20	20
1734	Pin $\frac{3}{4}'' \times \frac{3}{16}''$.	$\cancel{7} + {}^{13}$	$\cancel{20}$	$\cancel{20}$	9	—	—	—	—	—	—	$\cancel{20}^{10}$	$\cancel{20}^{10}$	20
1735	Pin $\frac{1}{2}'' \times \frac{1}{8}''$.	$\cancel{6}$	—	—	—	—	—	—	—	—	—	—	—	—
1736	Pin $\frac{1}{4}'' \times \frac{1}{8}''$.	6	$\cancel{40}^{20}$	40	$\cancel{40}^{22}$	40	40	40	40	40	40	$\cancel{40}^{20}$	$\cancel{40}^{20}$	40

FIG. 37

ASSEMBLY OF PARTS (AND APPROPRIATIONS) (*Contd.*)

TYPE Z UNIT

Number of Sets. . . .		2040	2060	2080	2100	2120	2140	2160	2180	2200	2220	2240	2260	2280
Drawing No.	Name of Part	Order Nos.												
		1627 12	1621 10	1906 10	1908 10	1910 10	1912 10	1916 10	1918 10	1940 10	2220 10	2241 10	2365 10	2368 10
		1622 8	1763 10	1907 10	1909 10	1911 10	1915 10	1917 10	1919 10	2219 10	2240 9 1	2241 10	2366 10	2369 10
1721	Bracket . .	2Ø	2Ø	20	20	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	20	20
1722	Gear . .	2Ø	2Ø	2Ø	2Ø	20	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø
1723	Crank . .	2Ø	2Ø	2Ø	2Ø	2Ø	20	20	20	2Ø	2Ø	2Ø	2Ø	2Ø
1724	Crank Pin .	2Ø	2Ø	—	—	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	—
1725	Frame . .	2Ø	—	—	—	2Ø	2Ø	—	2Ø	2Ø	—^{9}	2Ø	—	—
1726	Collar . .	2Ø^{8}	10	—	—	—	—	—	—	—	1	20	—	—
1727	Spring . .	2Ø^{12}	2Ø	—	—	2Ø	2Ø	2Ø	2Ø	20	2Ø^{10}	—	—	—
1728	Spring Holder .	2Ø	2Ø	—	—	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	2Ø	—
1729	Nut $\frac{1}{2}''$ . .	2Ø	2Ø^{10}	—	—	—	—	—	—	2Ø	—	2Ø	—	—
1730	Nut $\frac{5}{8}''$ . .	—	—	—	—	—	—	—	—	—	—	—	—	—
1731	Washer . .	2Ø	2Ø	20	20	20	—	—	—	2Ø	2Ø^{9}	2Ø	20	20
1732	Pin $1'' \times \frac{1}{4}''$.	2Ø^{8}	20	2Ø	2Ø	2Ø	20	20	20	2Ø	2Ø^{1}	20	2Ø	2Ø
1733	Pin $\frac{3}{4}'' \times \frac{1}{8}''$.	2Ø^{12}	2Ø	—	2Ø	—	2Ø	—	2Ø	20	2Ø^{10}	2Ø	2Ø	—
1734	Pin $\frac{3}{4}'' \times \frac{3}{16}''$.	4Ø	4Ø	40	40	40	4Ø	4Ø	4Ø	4Ø	4Ø^{18}	4Ø	40	40
1735	Pin $\frac{1}{2}'' \times \frac{1}{8}''$.	—	—	—	—	—	—	—	—	—	—	—	—	—
1736	Pin $\frac{1}{4}'' \times \frac{1}{8}''$.	4Ø^{16}	40	4Ø	4Ø	4Ø	40	40	40	4Ø	4Ø^{2}	40	4Ø	4Ø

FIG. 38

it must be distinctly understood that all alterations upon the card must be made by the clerk.

All cards and advance slips are dated, and it is understood that, generally speaking, work is put in hand in accordance with the date, i.e. a card dated 25th June should receive priority over one dated 6th July, etc. Sometimes, however, it is necessary for certain work to be hurried through, irrespective of the date upon the card, and in such circumstances a priority list is sent from the Progress Office to the foreman concerned. Work will be put in hand in accordance with this list, and when this is exhausted the original programme is reverted to.

Mention has already been made of the chart showing the foreman the work which lies ahead, and this is very useful in a Progress Office run on the lines now being described. The process work cards show the foreman the work actually in hand or contemplated, the advance slips show the amount of work available but not taken in hand, and the chart shows the amount of work likely to be available during the next few weeks. This chart is adjusted by the clerk responsible for the work in progress records, as the completed process work cards are received.

Apart from the placing of orders in accordance with the requirements, the Progress Office must see that sufficient orders are issued to keep each section or department fully employed. "Waiting time" is a direct charge against the progress man, and he must see, therefore, that the foreman has no reason or excuse for claiming this. The chart already referred to is of great assistance in this direction, but as the matter is of general interest, and is handled by different factories in different ways, it is proposed to deal with the matter in detail in the next chapter.

The system described in this chapter is in use (with slight variations) in many engineering factories manufacturing upon a repetition basis, and it will be seen that a large staff of expensive officials is unnecessary. The Progress Department must be commensurate with the task it is expected to perform, and an unwieldy organization is never an asset. One or two efficient progress men assisted by juniors can, in many factories, form an effective progress organization, and there is no reason, therefore, why the progress system cannot be adopted by the small factory as well as by the large concern.

CHAPTER XVI

PROGRESS IN THE SHOPS

No matter how well organized the factory may be, it is not always possible for every vice and every machine to be kept fully employed by means of orders for details which are issued strictly in accordance with the programme. It may be that the programme has been compiled with due regard to the capabilities of the factory—that the planning which preceded the compilation of the programme was efficiently performed—but the fact remains that there are occasions (and these fairly numerous) when the sequence of work through the shops is at variance with the planned arrangements.

That such happenings do occur is not the direct fault of any section or unit of the organization, and although, in the broad sense, responsibility must be charged to one section, the real fault is traceable to unforeseen circumstances over which the section has no control. To quote an instance, the trouble may be due to non-receipt of certain material, responsibility ostensibly resting with the Buying Department. This department can prove, however, that every effort possible has been made to get the material in to time. The order for the material was placed with a reputable firm, from which a definite promise of delivery was obtained, the period between this date and the time by which the material would be actually required leaving a substantial margin to cover contingencies which may possibly arise. "Speed ups" to the firm were frequent, and endeavours made to place another order with other firms with a view to getting the material in by the time required, all efforts, however, being in vain.

The Buying Department could therefore clear itself, but this is of little satisfaction to the factory. So far as output is concerned, the matter was not probably of immediate importance, and, assuming that the material was received, say, within a further two weeks, output from the factory need not necessarily suffer. The deflection, however, made a gap in the programme, and that particular job could not be put in hand because no material was available. So a substitute job had to be found in order to keep the vice or the machine fully employed.

It may be said that this is not a formidable proposition, and were but one or two orders affected, indeed, it would not be so. It is, however, when cases become numerous that trouble is occasioned, and nowadays with the question of raw supplies in such a critical position the problem of the "alternative" job has to be solved daily.

It is not only in connection with the first process that the difficulty has to be surmounted, for it extends to all sections which have to handle the part. It may be that the turning section cannot proceed because the casting has not been received, but sooner or later the trouble will extend to the drilling section, and later still to the milling section. Although an "alternative" job may be found for the turning section, it by no means follows that this will obviate trouble in the remaining sections, so that it would seem that each section must be dealt with on its merits.

The Planning Department cannot make provision for these contingencies, and any attempt to do so would eliminate "planning" entirely. The Planning Department must assume that "things *will* be so" and not "*may* be so." It must be positive, and only the very narrowest possible margin left for contingencies. It is upon the Progress Department that the burden falls for, as before explained, "the Progress Department must ensure that the aims of the planner materialize."

The progress man's association with the manufacturing departments, then, means a dual responsibility, for he must (1) provide the facilities whereby the commitments of the firm are met, and (2) provide the facilities whereby every section of the factory is fully employed. So long as there is a sufficiency of parts really required, the problem of keeping the shops fully employed is solved, but when such is not the case, then "alternative" work must be provided, this taking the form of work which will not only prove advantageous from the employment standpoint, but also from the standpoint of utility.

Owing to the movement in favour of specialization, it is possible for a section or department to have plenty of work on hand, and yet for one machine or vice to be suffering from a shortage. It may be here that the organization is at fault, the system of rate fixing being primarily responsible. Rates or times are fixed at such fine limits that the foreman's choice of vice or machine is extremely limited,

although the foreman cannot altogether escape responsibility. Notwithstanding the rigidity of rate fixing regulations, the foreman is not supposed to be devoid of intelligence, and he can, if he chooses to exercise his ingenuity, supplement the advantages derived from efficient rate fixing, and so distribute the work in his section to ensure the best possible results being obtained.

This distribution of work is not the progress man's responsibility, for he does not determine the job for the man. Process planning decrees that a certain detail shall pass through certain sections in order for operations to be performed, and the progress man's business is to see that the part goes through each stage in the correct sequence, or as near that as possible. He cannot insist that such a part should be handled by a certain machine, but he can insist upon the process being completed and out of the section by a certain date, leaving it to the foreman to provide the ways and means. Whatever method is favoured, therefore, for ensuring adequate work for every operator, the onus is upon the foreman to apprise the Progress Department of the range of work which can be handled by each individual.

One rate fixing system, which the writer believes is operating in an American factory, gets over the trouble to a great extent by specifying, when issuing particulars of a new process, the machine which can most expeditiously perform the work. This is known as the "first choice," but the rate fixer, appreciating the fact that the first choice is not always available when required, denotes a second, and a third, and, perhaps, a fourth choice, with a slight variation in the rate in each case. This method has much to commend it, for although the process handled by the "third choice" would cost a little more than if handled by the first, there would probably be a saving in two directions—one by ensuring that the part would go through by the date required, thus obviating a delay in the later stages, and the other by a judicious distribution of work, resulting in every machine in the section being fully employed.

Imagine the first choice with six jobs, and the third choice with none—in all probability important work being held up owing to the inability of the first machine to cope with it, whilst the third machine is idle and therefore a dead loss. Yet this may easily happen. It may not be desirable here for the rate fixer to eclipse

the foreman so completely, but rates should permit of adjustments to meet varying conditions, and, the "first choice" being the privilege of the rate fixer, the second or third could be left to the discretion of the foreman.

One method of dealing with the distribution of work is to arrange for three jobs always to be available for each machine. This means that the first job is actually in hand, the second ready to be picked up, and the third in the store, available upon demand. Thus, when the first job is completed the second is immediately taken in hand, and the third demanded from the store, which means that straightway another job must be placed in the store to take the place of the one demanded.

This works very well in connection with first operations when adequate supplies of material are forthcoming, but it becomes rather complicated when applied to later operations, and although at one certain time the three jobs outlined are available for one machine, it is very difficult for this to be continuous. The jobs have to come from a variety of sources—it is true that, so far as that machine is concerned, job number three emanates from the store, but it may have to pass through a number of sections before getting there, and the farther it goes the greater the difficulty.

Another point is that each process is not of the same duration. One machine may have three jobs and be occupied three weeks, whilst another may have three jobs and be occupied but three days. Feeding a machine with long operation jobs is a comparatively simple matter, but it is quite a different proposition to plan ahead on the short operations. Rather than three jobs per machine, the better method seems to be to plan the work for each machine two or three weeks ahead, irrespective of the number of jobs involved, and if this is accepted and put into practice, each foreman can see precisely what work is available for a definite period.

Various methods are used for apprising the Progress Office of appropriations of work to the several machines, of which two may be mentioned. The first is used when all process work cards are made out in advance, these being filed in the Progress Office under the process section, i.e. all drilling cards under "drilling," each card filed in consecutive order, using for this purpose the drawing number of the piece or the work order number, according to which

is favoured. Thus, at a glance, a rough estimate of the amount of work still to pass through any section can be made, for if the number of work cards under any one section is small, it is speedily apparent that there is danger of a shortage in the very near future, and steps could be taken to endeavour to remedy this state of affairs. It is known that none of the material covered by these cards is in the section because, where this method is adopted, the practice is to send the card to the section with the job.

To enable the progress man to locate any job, and thus be able to arrange for the work to be in a certain section by a given time, a master work card is held in the Progress Office, this giving the whole of the processes in connection with the part in question, each process being marked as completed. The master card, marked to show that the turning operation was the last process completed, and giving milling as the next operation, tells the progress man that the work is either in, or available for, the milling section, and that the work card for that process is in the hands of the milling section foreman.

The section foreman has a number of process work cards, and at the earliest moment he plans the work in his department by allocating it to the various machines, sending a notification in the form of a small card to the Progress Office. This card gives brief particulars of the job and the number of the machine (or operator) to which it has been allocated. A rack (similar to the one usually associated with the automatic time recorder, and used for holding time cards) is affixed in the Progress Office, and the notification card received from the foreman is placed in the slide bearing the number given on the card (card allocated to No. 70 machine being placed in No. 70 slide).

If this is carried out efficiently there should be always at least one card in every slide, and should there be a surplus slide (owing to the removal of a machine or operator), this is provided with a dummy card, a machine under repair denoted by a card of a distinctive colour. A glance at the rack will show at once the number of machines in one section under repair, whilst a slide without a card would be as easily detected, thus showing that something was radically wrong, and instant attention demanded.

The progress man, then, can see how the work is distributed, and he will probably observe that, whilst one slide holds but two cards,

another holds six. The master card will show the time allowance in each case, so he can easily determine how long the work will last. It may be that the work represented by the six cards will be exhausted before the work represented by the two cards on account of shorter processes, but, on the other hand, it may be found that the work has been unequally distributed, in which case the progress man would draw the attention of the foreman to the fact, and the onus is upon the latter to prove that he has distributed the work to the best advantage. The notification card is taken from the rack upon receipt of the completed work card bearing the corresponding number.

The other method is used in conjunction with the system described in the last chapter, and in this case the process work cards are not made out until the material is actually available. When a work card is made out it is retained in the Progress Office, and a slip bearing a corresponding number is sent to the foreman, as already explained. The foreman plans his work from the slips in his possession, writing upon each the number of the operator to whom the work has been allocated. The slip is sent to the Progress Office and exchanged for the work card, the former being retained in the Progress Office and pinned to a board under a corresponding number.

The procedure then is similar to that already described, the progress man referring to the board for information concerning the distribution of work. A notification from the stores showing that material for a certain job had been sent to the section would result in a stamp being affixed to the corresponding slip, this denoting that the job was actually in process. The board then would show under one operator's number, say four slips, one of these bearing a stamp, and this would show the progress man that that operator had a job in hand, and three other jobs available. The receipt of the completed work card would result in the slip bearing the corresponding number being taken from the board.

The two examples quoted are easily handled and are very effective. They can, of course, be elaborated, but worked in the manner described there is little fear of mistake, and they can be handled by a junior. The rack, or the board, is of the utmost assistance to the progress man, and oft-times determines his course of action. Apart from ensuring equitable distribution of work,

it will show the progress man how that distribution will affect his plans—for instance, a certain part is urgently wanted, and the board shows him that it has to follow two other jobs. Should these latter not be so urgently required, a talk with the foreman will result in a re-arrangement which will ensure the urgent job receiving priority over the others.

CHAPTER XVII

PROGRESS CHASING

WHILST the methods described in the preceding chapters make it possible for the Progress Office to be in possession of all information relating to the progress of details through the manufacturing departments, it must not be assumed that the direction of detail can be made by the man in the office. He, no doubt, sets the wheels in motion, but for these to run without friction lubrication is necessary, and this brings us to what is commonly termed "progress chasing."

This is, in reality, the oldest form of progress work, for even in the unenlightened days of the engineering industry, a "chaser" was in evidence—a man who ran about and collected together the details comprising an assembly in order to keep the mechanics employed. This individual was under the control of the foreman of the department to which he was attached, and his interests lay wholly and solely in that department. His business was to locate "missing parts," and having done so, to endeavour to get them through their remaining processes as quickly as possible.

From this beginning the modern chasing system has been evolved, but whereas the earlier chaser looked after missing parts (he being usually located in the assembling or fitting department), the duty of the present day chaser is to ensure that there are no "missing parts." Chasing to-day starts with the first department and not with the last, and if the system is efficient there should be no need for a chaser in the assembling shop.

Chasing now forms part of the progress organization, and the chaser, no matter to which department he is attached, is controlled by the Progress Office and not by the department foreman. The methods employed by the chaser are dictated by the policy of the Progress Department, this necessarily varying in the different factories, although the principle is the same. The chaser is the progress man's assistant. He is the man who looks after the detail, speeding it on where necessary, and ensuring that every part receives the attention to which it is entitled. Being in the factory,

he can obtain first hand information, and it is upon his reports that the progress man can compile his records and make new estimates.

It is proposed in this chapter, to show the progress chaser at work under different conditions, and it is hoped to demonstrate that he is a very useful individual, assisting in no uncertain manner, and well worthy of his place in the factory organization.

For the first illustration we will take the chaser directly attached to the Progress Office in a factory engaged upon various lines of manufacture. The Progress Office was divided into sections, the head of each section being responsible for a certain product. Assume, then, that number one product is in charge of A, who is progress section leader, and who has B as his assistant, or chaser.

Number one product is of the semi-standard variety, assembled to customer's orders, 70 per cent of the parts being drawn from stores, and the remaining 30 per cent processed in the shops. The section leader (A), upon receipt of the specification list, sends out the completion dates to the manufacturing departments concerned, and then makes up a progress sheet which he hands to the chaser.

This progress sheet (see Fig. 26) tells the chaser that the completed unit must be out of the factory by 27th August; that for this to be accomplished the castings must be out of the foundry by 10th August; that all parts must be machined by 20th August, and that the Assembling Department must complete the unit by 24th August. Every item which is to receive special attention is enumerated (these comprising the 30 per cent already referred to), but those items which can be delivered from stock are not given in detail.

The chaser must be familiar with the product, and so be able to deduce the significance and relative importance of every item. For instance, he will not worry prematurely about a certain detail which is not required until the later stages, but will immediately concentrate upon the parts which will be required first. The manufacture of the unit is probably done by sub-assembling, the whole of these sub-assemblies being finally erected to form the complete unit, and it may be that one or more of these sub-assemblies is comprised exclusively from the parts drawn from stores. Having satisfied himself that these parts are available, he considers the next sub-assembly, and discovers that one or more details must be specially machined.

To illustrate this more clearly we will assume that number one product is a 15 horse-power induction motor. The stator core must be assembled and delivered to the Winding Department by a certain date. The details for this assembly being drawn from store no difficulty is apparent, but assuming that the laminations must be specially punched, the chaser must get these before the core can be assembled. The rotor core is handled at the same time, but assume that the shaft must be specially machined! The core is built on the shaft, so until the latter is forthcoming no progress can be made in the assembling shop.

The shaft, then, must come from the machine shop, and so must the end-shields, bearings, collector rings, and a host of other details, and the machine shop is given a date by which the *whole* of these details must be completed. The end-shields, bearings, etc., are not wanted until the unit is ready for final erecting, i.e. after the stator and rotor have been wound, and, so long as these parts are ready by the date given, all will be well. But the shaft is different, for the rotor cannot be wound until this is ready, and it is obvious, therefore, that the machine shop completion date will not do. The shaft must have preferential treatment, and it is to ensure this that the progress chaser must be familiar with the product. He must *know* that that shaft is wanted first.

The stator and rotor cores having reached the Winding Department in accordance with the date given, the progress sheet tells the chaser that this department has two weeks in which to complete the winding, and as the wire is drawn from store he has no need to worry about this process for at least a week. He therefore turns his attention to the parts which are required in connection with the final assembly—the end-shields, bearings, and so forth, and concentrates upon the task of having these ready by the time the stator and rotor are received from the Winding Department. If special castings are required, he must start at the foundry and, having got them, must then pilot the parts through the machining processes. The real point here to be noted is that the chaser does not concentrate upon the end-shields when a special shaft is required.

The stator and rotor being wound, and all the details comprising the unit being available, the final erection follows, and the chaser's duty here is to see that the completion of each unit is in accordance with the date given. For the purposes of illustration we have

followed the progress of one unit, but it must be borne in mind that actually the chaser is interested in perhaps a hundred or more different units at the same time. Not all of these will be ready for final erection at the same moment, for the movements of the details comprising these have been planned by the progress man. Still, in spite of planning, it is possible for an order due next week to be in the Erecting Department at the same time as one due this week, and when this happens it is the duty of the chaser to see that the last-named is handled first.

It may be observed that this must of necessity follow, but it is not so. It must be remembered that the units are of various sizes, and the percentage of special features is higher in certain cases, these involving longer time in erecting. In the factory where piecework rules, it is in the interest of the operator to complete by the end of the factory week what orders he has on hand, for should an order be uncompleted, bonus is withheld until such time as it is completed. In another case the department aims at a certain production each week, and to ensure this there is the tendency to push through, toward the end of the week, one or two units of simple construction, which are perhaps not due for completion until the following week, because these *can* be completed and so make up the number, whereas the unit which should be taken in hand cannot, on account of special features, be got through by the week-end.

Taking the 15 horse-power motor already referred to, we will assume that this is in the erecting shop, but is not due for completion until the latter part of next week. In the department there is another unit which is due for completion on Monday of next week, and, in order that this date be kept, the work should be put in hand on Thursday of this week. As it is impossible to put the work in hand before Thursday, it means that the unit cannot be completed by the end of the current week, and so the operator has an unfinished order (upon which no bonus can be paid), and the department suffers a loss in output. The first-named 15 horse-power motor, if taken in hand on Thursday, could be completed by the end of the week, and thus make both the operator and the foreman happy.

This is done, and the unit gets through in advance of the date given, but what of the other? This is taken in hand on the following

Monday, the day upon which it should have been completed, and as at least two days are necessary for erection, the progress man's estimate is quashed. It is to guard against this that the chaser must watch, reporting at once any move made in this direction.

It will be seen by the foregoing that the chaser directly attached to the Progress Office has plenty of scope to display his abilities. In close association with both the office and the shops he has a unique opportunity, for chasing is the finest apprenticeship course a progress man can have. Without it his chances of real success are small.

Another chasing system which is effective is for a chaser to be attached to each manufacturing section. Thus in the machine shop a chaser would be attached to each of the following sections, viz. automatics and capstans, turning, milling and gear cutting, drilling and slotting, etc. The chasers are controlled by the Progress Office, and are not subservient to the authority of the section foreman.

Each chaser has a priority list, which is kept up to date by the Progress Office, and it is the duty of the chaser to offer every facility to the foreman to ensure the work being put in hand as required. He cannot, of course, issue any instructions to the foreman, neither can he distribute the work, but he must arrange that, so far as he is concerned, there is no reason why the work cannot be handled according to the list. Every morning he reports to the head progress man, and if a job has not been taken in hand he must give the reason.

Upon receipt of a priority list the section chaser goes through it, item by item, and makes sure that the material, work cards, tools, and drawings are available. Should anything be missing he must locate it, and report to the Progress Office any factor likely to cause delay. Should everything be in order, he consults with the foreman, and the programme for the day is drawn up. Everything of note is entered on the priority list, so that, when he presents this to the Progress Office on the following morning, a complete survey of the previous day's work is obtainable.

Bearing in mind the fact that each detail has to pass through the Inspection Department after every operation, it is necessary for the "chasing chain" to be continuous. A section foreman is responsible for the detail only whilst it is in his section—that is to

say, he is not concerned with its whereabouts *before* it reaches him, neither is he interested in the detail *after* it has left him. The chasing system, then, must link up the sections, and in the scheme now under review the following procedure is adopted.

A priority list is posted just inside the Inspection Department, and upon this the work is entered as it arrives for inspection from the different sections, this being done by the chaser attached to the section from which the work has been sent. For example, 200 camshafts have left the turning section, and these, accompanied by the order or work card, are received in the Inspection Department, the chaser attached to the turning section recording the fact upon the priority list posted in the Inspection Department.

The inspector works to this list and cancels the item as it is completed. The section chaser notes this, and his responsibility ends when the job has passed inspection. Should it appear that a certain item is not receiving attention, a notification is sent to the chief inspector, but it is understood that no chaser has the right to endeavour to get a job through inspection at the expense of one belonging to another chaser. To illustrate this more clearly, assuming that item number seven on the list refers to a job received from the milling section, whilst item number eight covers a job received from grinding, the first-named job must (if at all possible) be handled first by the inspector, although it by no means follows that it will be completed first.

One other chasing scheme may be described before bringing this chapter to a close, and this refers to the small factory where one chaser can handle the whole of the work. Here, of course, he has the run of the factory, but it is just as necessary for the chasing to be handled methodically as in the larger factory, where "system" is, perhaps, more pronounced. Nothing upsets a foreman more than haphazard chasing, and much of the criticism directed against chasing may be traced to the lack of system and method.

The chaser is in evidence when there is a likelihood of things going wrong, and it is in this connection that his actions are liable to be misunderstood. Knowing what he wants and when he wants it, he can see farther than the foreman of a section, who is apt to resent a suggestion that, unless attention is given to a certain part, there is a possibility of delay at a later stage. "You are not waiting for this," says the foreman. The chaser agrees! Of

course he isn't waiting for it. His business is to obviate that, and he brings the pressure to bear early enough, for he doesn't want to wait for it.

There have been many instances where the foreman has refused to listen to the chaser, and the latter has been obliged to report the facts to the Progress Office. The case is taken up, and the foreman shows that he can do the job by a certain time, and actually makes good his boast. On the face of it, therefore, the chaser is at fault, but the real fact is that, had not the case been taken up, the job would not have been done, and the chaser would have been censured.

The "one man" chasing scheme is (like the others) governed largely by the method of manufacture, and the first illustration is where the manufacture consists of a number of details, which have to undergo perhaps a dozen or more different operations. It may be that the material is cast iron, and that the details are put into process in batches of 50. A progress chart is compiled, each batch distinctly marked, and all operations shown in the correct sequence. The chaser has to see that sufficient material is available for the batches, and then to show the progress of each batch upon the chart. So long as supplies of material are forthcoming, and each section can handle the work in accordance with the programme, the chaser's work is not really difficult. It is when material supplies are erratic, or other details clash in process, that the chaser's duties become more complicated, for it is then that contingencies arise which demand very delicate handling.

Where all parts are manufactured for stock, and drawn from there by the assemblers in definite batches, the chaser works upon a "shortage list," or, as it should be more correctly called, an "impending shortage list." Assembling orders are made out in advance and not as required, and by this means it is possible for the Progress Office to know ahead the parts which may cause delay. Thus, to-day, orders are being made out for the assemblers, which will not be handled for three weeks, and in connection with these orders certain details are not in store. The chaser takes note of these and concentrates upon the task of getting them into store by the time required.

A separate shortage list is made out for each assembly, and particulars regarding the whereabouts of each item obtained from

the progress record card. The chaser then has something to work upon and can, if necessary, arrange a priority list for each section. In this way progress chasing is a help—to the foreman, the Progress Office, and the factory generally. The chaser can ensure that time is spent to the best advantage by an intimate knowledge of the requirements of each and every section. He knows that the details covered by a certain order or work card are wanted by a given date, and he arranges that the material is available, wherever or whenever it is wanted. Having got the material, he draws the foreman's attention to the fact, and the latter knows that, each time he puts a job into process at the chaser's request, he is handling a job which is really needed. The chaser does not urge work through the shops in order that it may remain in store for a lengthy period; he urges it because it is wanted—perhaps not immediately, but in the very near future.

CHAPTER XVIII

INTERNAL TRANSPORT

It will be observed that the transit facilities in this country leave much to be desired, and as a consequence business does not yield the results anticipated. We can often produce but cannot get the product away, whilst on the other hand we cannot produce because we are unable to obtain the raw material; whichever is the case, it makes production limited, and the more highly organized business becomes, the more inadequate proportionately are the transit facilities, and the greater the loss in consequence.

With such an example before him, the manufacturer must take heed lest his own business suffers still more on account of the inadequate transport system operating in his factory. It is unfortunately true that in many factories this part of the organization has not received the attention to which it is entitled, and surprise is expressed because the results aimed at are not achieved.

Thousands of pounds are spent upon improving actual production methods, expensive machines are installed, new tools and jigs are designed, and every effort possible is directed towards the process of "speeding up." Yet something is wrong. Anticipations are not fulfilled and still more money is spent in the same direction, in the hope that, ere long, results will begin to be made manifest.

The planning system is well developed, and an efficient Progress Office is established. The capabilities of every section in the factory are calculated to a nicety, but, unfortunately, these calculations do not materialize. There is a weak link somewhere, and even when at last this weak link is located, its significance is not altogether appreciated, for instead of transport being treated as a definite organization, it is simply "patched up," and an endeavour made to hide the defect by speeding up other sections.

This will not do. The factory demands that the transport organization shall be efficient, that production is not limited, and that progress is not retarded. If production methods are introduced to ensure a section handling one hundred sets of detail per week,

then the transit facilities must be such as will allow for one hundred sets of material to be received into the section, and one hundred sets of details to be sent out of the section each week. These two factors govern the situation if the section is actually capable of producing the number aimed at.

If adequate supplies of material cannot be got into the department, the result is obvious so far as output is concerned, for if it is not there, then it cannot be manufactured. But assuming that the material is there, and cannot be got away, the ultimate result is the same. The section must be systematically cleared in order for the maximum results to be achieved, for efficiency is impossible in a "clogged shop." Thus, the manufacturing organization, no matter how efficient it may be in itself, is rendered inefficient by defective and inadequate transit facilities.

In like manner progress suffers, for it must fall short of the estimate. The progress man may get the best result possible from the facilities provided, but those results fall far short of 100 per cent. He may be blamed unjustly for failing to achieve the impossible, it being pointed out that as the factory *can* produce a given output it is up to him to see that this output is maintained. But what can he do? If the transit facilities offered consist of a number of trucks upon which a huge number of heavy parts must be transported, when a two ton crane is really necessary, the best he can do is to ensure those trucks being worked to their maximum capacity. But there is a limit to this, and that limit is soon reached. The position is an impossible one. An inefficient section must adversely affect the efficient section, for it is always more easy to pull down than to build up.

It having been decided that the transit facilities must be commensurate with the need, the next business is to ensure this. It is not intended in this book to advocate any specific system in regard to appliances, for it is recognized that the method operating with every success in one factory will not ensure the same measure of success in another. One manager may swear by the overhead system which meets his need in every direction, but overhead cranes and runways cannot be installed in every factory for structural reasons, whilst, apart from this, the class and the method of manufacture may lend itself better to some other method of transport.

The system to install, then, is the one from which the best results may be expected, the least expensive one commensurate with the part it has to play. There is no need to install an expensive system if it cannot be utilized to the full, just because the man next door has one. He may get value for money, but that is not to say that you will. He may laugh at your little service, declaring it obsolete and out of date, but so long as it is doing all that is required of it (and you *know* it) it will serve the purpose perhaps better than a more elaborate system.

It may be that in one part of the factory the overhead system is the most efficient, whilst in another part floor trucks can be used to better advantage. If this is the case, then the amalgamation of the two systems will produce the most efficient transport organization, and there is no call to install the overhead in the departments adequately served by the other method. It is, of course, necessary to look ahead and to recognize that, in order to cope with increasing demands, a more elaborate system may be necessary in the future, but if, when extending the production capabilities of any department, the claims of the transport organization are also brought under review, the matter is adjusted automatically.

The transport organization is linked with progress and must, therefore, be under the control of the Progress Manager. It is essential that the chain is continuous, and there must be no loose ends consequent upon departmental transport being controlled by the various foremen. A foreman, as before explained, is concerned wholly and solely with his own department, and as very few orders are entirely executed by any one department, all departments must be linked to ensure continuous progress.

The progress system provides the link, and the chasing systems, already described, lend themselves to the utilization of transport with a view to ensuring the maximum results. Where chasers are installed in each section this is particularly applicable, for there the chaser controls the section transport, this enabling him not only to get the job done but to get it out of the section. Think what folly it would be if, the job being completed to time, it could not be removed except with the authority of another person. The real meaning of chasing would be destroyed.

Leaving the transit appliances to be dealt with later, the principle and practice of internal transport may now be discussed, and here

the Inspection Department and the Progress Office are both vitally concerned. Transport denotes a movement, and the progress principle is that every movement shall be recorded. A movement also denotes the completion of a process, and, apart from the interest this excites in the progress man, it is a matter of import to the inspector, seeing that an examination of that process is necessary before the part can proceed.

It is generally accepted that no detail can be received in any department or section until it has passed the inspector, and so transport in every instance must be either to or from the inspector. In some factories the parts must actually be received in the Inspection Department, but in others the inspection is carried out in the manufacturing section, and it is proposed to illustrate the two methods.

In the factory where each part is actually received into the Inspection Department after each process, it is desirable that the department be in a central position, so as to reduce handling and transit as much as possible, it being easily accessible by means of the facilities provided, whether the floor or overhead system be operating. In the large factory an inspection room is attached to each self-contained manufacturing department, but in the smaller concern one central Inspection Department caters for the needs of the whole factory. The system of transport may, however, be the same in either case, the departments in the large factory each being considered for this purpose a separate factory.

The Progress Office (or the head chaser's office, whichever may be more convenient) is in close proximity to the inspection room, so situated as to permit the passage of all goods to and from inspection past the window. By this means all movements are recorded without loss of time, and without unnecessary work.

The section foreman, having completed a process in accordance with a work card, signs the work card and hands this to the section chaser who arranges for speedy transport. It must not be inferred that as soon as a job is completed it must be rushed to the inspection room, for were this to be the case then no transport system would be efficient. The chaser arranges for a systematic clearance at certain periods during the day, a full load being made up where possible. Further, it should be arranged that there are no empty journeys. The man takes a load *to* the inspection room, and brings

another load back. This is not at all a difficult matter if the system is efficient, and it is really necessary if the maximum results of the transport system are to be effected.

The transport man is given the work tickets, and he must be certain that his load comprises the parts shown. The chaser is, of course, primarily responsible, and every item must be checked ere the load is released. The load is taken towards the inspection room, but halts outside the Progress Office. The work cards are handed in at the window and the necessary records made by the clerk. It may be that a master card must also accompany the job to the inspector, and, if so, this is given to the transport man together with the work card. The inspector will refuse to accept any job unless accompanied by the work card and also the master card, and this prevents the possibility of any job getting into the inspection room without being recorded in the Progress Office. Should the system not allow for a master card, the process work card is endorsed by a Progress Office stamp, and this serves the same purpose.

Having been duly recorded, the load passes to the inspection room, where it is received by the checker. This individual ensures that everything is in order, and he may, by arrangement, enter all the goods upon the precedence list described in the previous chapter. The load is then deposited in the inspection room, and a load of inspected parts, destined for the section to which that specific transport man is attached, is taken up. This load, of course, consists of parts which have been inspected for a previous process; for instance, certain parts have been inspected for turning, others for drilling, etc., but the whole must go to the milling section for the next process.

The completed work cards, duly signed by the inspector, are handed to the transport man, and the return journey is commenced. Again a halt is made outside the Progress Office, and the work cards tendered. A record of the movement is made, but this time the work cards are retained, and in their stead are given work cards relating to the new process, e.g. milling. Here again is the assurance that the movement of the parts has been recorded, for the chaser will refuse to receive any goods into the section unless accompanied by a process work card.

It will be observed that under this system the goods pass from

a section to inspection, and from inspection to another section, without passing through the store, whilst it will also be noted that goods must be received into a section, even though these cannot be put into process at once. Many firms favour the system under which all parts must pass from the inspection room to the store, there to remain until demanded for the next process.

This system is handled in the following manner. The journey to the inspection room is made in precisely the same manner as the foregoing, but there is no return load *from* the inspection room. This department adjoins the stores, and after inspection the goods (with the work card) are passed over the counter by the inspector and received by the storekeeper, who passes the necessary notification to the Progress Office. To ensure that there is no empty return journey, however, the section chaser hands to the transport man new process work cards covering the parts which are wanted for process, and after delivering his load to the inspection room the transport man hands the new cards to the store, and receives the parts enumerated thereon.

In regard to the other system mentioned, under which the inspection is carried out in the manufacturing section, if there is an inspection bench all parts are transported to this, but should the inspector be of the "travelling" variety, no handling is necessary, because the inspection is carried out at the bench or machine upon which the process has been completed. When the parts have been examined and passed, the inspector signs the work card and hands this to the section chaser, who makes out a shop delivery note (in triplicate), sending the first copy with the goods to the department responsible for the next process, or to the store (whichever system may be in operation). The second copy is sent to the Progress Office, and the third retained on file. If a signature is desired to prove receipt, the first and third copies of the delivery note are sent with the goods, the third copy (duly signed) being brought back to the section by the transport man.

This system saves a fair amount of handling time, and it can be made still more effective if a load can be got ready for the return journey. This, however, is not always possible where other sections are concerned, but where all goods are sent to the store the same procedure as mentioned above can be adopted. Where the parts move direct from section to section it is possible, unless precautions

are taken, for a certain amount of overlapping to occur. The transport man from, say, the turning section will bring a load to the drilling section, to find that the transport man attached to that section has just left with a load of work for the turners.

Under this system it would seem the better plan to have the transport men under a central authority, say the chief chaser, instead of being attached to specific sections. Thus, a man would arrive in the drilling section with a load of work from the turners, and having delivered this he would pick up a load to take to the milling section, and from there a load to the grinders, and so on. Two or three men, thoroughly understanding their duties, would keep things moving, and there would be no question of wasted time consequent upon empty journeys. Each section would be catered for in accordance with its needs. If there is plenty of work, then it can be handled without delay, whilst should there be a slack period, then the transport man would be elsewhere working, and not standing by until such time as there is a load demanding his attention.

CHAPTER XIX

TRANSPORT APPLIANCES

MECHANICAL appliances as aids to transport are many and varied, and although, as stated in the preceding chapter, it is not proposed to advocate any specific method, mention of the appliances which are familiar to the writer, together with brief comments upon the advantages of each under certain conditions, may well form part of this section. Any system, however, must be considered in relation to the nature of the work to be handled as well as to the size and lay-out of the factory.

One of the most effective systems, especially in the factory where continuous and rapid transport is essential, is undoubtedly the overhead system, this being most comprehensive, and designed to cater for every emergency, assuming that the structure of the factory buildings will allow for its installation.

Where the building takes the form of bays, and the material to be handled is of the heavy variety, the travelling electric crane, running along an overhead gantry, is eminently suitable. This is made in all capacities, from two to thirty tons or more, and controlled in a variety of ways. It may be entirely electrically controlled—main traverse, cross traverse, and hoist, operated by a man in a travelling cage, or it may have a hand traverse and electric hoist, operated by a man on the ground. In the foundry, the erecting shop, or the machine shop handling heavy parts, this crane is much in evidence and is a real necessity.

The travelling hand crane is somewhat similarly constructed, except that it is entirely operated by hand. This is made in capacities varying from two to ten tons, and is designed for use under similar conditions to the electric crane, but where the loads are lighter and rapid movement is not so essential.

The travelling pulley block is designed as an auxiliary to the travelling crane, or for use where it is not practicable or necessary for a crane to be installed. The electric travelling pulley block is for use where there is plenty of room, notably in the long shaped factory. Goods received from outside sources may be picked up at the

entrance gate and taken direct to their destination; but for this block to be a paying proposition it must have a number of departments to feed, so that it is kept busy continuously.

The hand travelling pulley blocks are, so far as traverse is concerned, of two varieties—the bogie type and the switch trolley type; whilst in either case the hoisting gear may be built into the trolley, or built as a separate unit and hung to the trolley, the feature of the latter arrangement being that the hoist can be transferred, if desired, to another trolley.

The bogie traveller runs upon a straight joist, although it can negotiate curves if fairly wide. Its scope is somewhat limited, but it is a very useful appliance nevertheless. In a shop with a straight run one bogie traveller can feed several machines, and it is very handy when the process demands that heavy material must be lifted on to a machine table, and set down again perhaps a number of times. When the process is completed, the material can be run direct to the inspection room if this is situated suitably.

There are endless possibilities in the switch trolley traveller, this being one of the most efficient modes of transit. It can go anywhere, and the writer has seen material placed on the traveller direct from the stores locker, and transported without further change to the machine for which it was intended. This is made possible owing to the fact that the trolley can negotiate "points" and so pass along different sections of the track. One man can handle from 5 cwt. to 10 cwt. with ease, and the switch trolley traveller is a most economical proposition.

Both the bogie and the switch trolley types of traveller are fitted with chain hoists, but in regard to lowering, although in the main this is done on a chain, it is possible to have a block fitted with a gravity lowering attachment, which greatly enchances the speed. Thus, when the load is to be lowered, instead of paying out the chain, a cord is pulled, which releases the brake and the load descends. This is well under control, for immediately the cord is released the brake is in gear, and the load remains suspended.

These hoists can, of course, be used without travellers, being suspended from a beam in the position desired. For the millwrights the rope hoist is very useful, this being quite light and can be easily carried about and fixed in position.

Conveyor transport, by means of an endless belt, is rapidly increasing in popularity, but for the best results to be obtained it is necessary for the building and the lay-out of the factory to be on modern lines. The older established factories, not being constructed upon scientific principles as now understood, are not so amenable to the conveyor system as are the factories but lately constructed, and it is in these latter that the possibilities of the system may be more fully exploited.

Coming along to floor transport it would seem that, in many instances, the assistance of overhead hoists is necessary. There are, however, exceptions to this, notably in regard to travelling jib cranes and lever platform trucks. The former, as the name implies, is a hoist attached to a jib, this being mounted on a carriage for the purpose of floor locomotion. Thus, the job can be lifted and conveyed to its destination with very little trouble.

The lever platform truck marks a big advance in floor locomotion, and not only so, it influences the method of dealing with material after the process is completed. Briefly, the platform is a loose floor for the truck, and upon this are placed the parts for transportation. The truck conveys the parts to their destination where, without further handling, the platform with the parts still on it is left, the truck only being removed for work elsewhere with other platforms.

One of the chief drawbacks to floor locomotion with ordinary trucks is the fact that a large amount of handling is involved. The parts are placed upon the truck, conveyed to their destination, and then unloaded, this taking up a good deal of time. The only alternative is to leave the parts upon the truck until taken into process, in which case the truck is idle for a period, not being available for other work.

When the lever platform truck is used the method is for the operator in the manufacturing department to have upon a platform work which he is about to put into process, and as each article is completed it is placed upon another platform Thus, when the process is completed on all the articles comprising a batch, these articles will be found on platform No. 2. The lever truck, bringing up another batch of parts, deposits these (still upon a platform) in the section, and the base of the truck is then run under the second platform, and the goods thereon are conveyed to the Inspection Department or the store, as the case may be.

It is not proposed to describe the mechanical workings of this truck, but the great feature is that the truck is always free, except during the actual period of transportation. This is a very important matter, for in the factory where all transport depends upon floor locomotion, there must, if ordinary trucks are used, be an excessive number in order to allow for a proportion of temporarily idle trucks, or else the handling is excessive. Even then there are occasional delays in transport, due to a shortage of trucks in a certain section of the factory, for it is almost impossible to ensure equitable distribution throughout the factory.

In circumstances where tiering is necessary the elevating platform truck is valuable. For example, should it be necessary to pile heavy articles to a height of about 6 ft., one of these trucks can be used to transport and elevate the article to the correct height for pushing into position.

Other means of floor locomotion include the track bogies and the ordinary run-about trucks. The former may be electrically propelled (where the area to be served is large enough to justify it) or propelled by hand. The advantage that the bogie has over the ordinary run-abouts is that heavier loads can be easily handled, but a track bogie must of necessity have a somewhat restricted scope. It is also liable to congestion, and as a consequence (generally speaking) transit is somewhat slow.

The run-abouts are very handy for light work, and compared with the track bogie are fairly rapid, seeing that their movements are not restricted to the same degree. A parallel is afforded in the street traffic, the tramcars, although of huge capacity, depending upon a clear track for their movements, whilst the omnibuses, howbeit with lighter loads, can transport more rapidly on account of the freedom of movement.

Run-about trucks are of various designs, and some of these are more suited to specific manufactures than others. A truck should be loaded to the limit of its capacity, but with certain parts the full load (on account of peculiarity of construction) is quite inadequate. It is not wise to have too many differently designed trucks in the factory, as this again tends to limitation of use. The more effective way is to have a number of trucks to one design, and to equip these with removable racks specially designed for the peculiarities of manufacture, with a view to ensuring a full load no matter upon

which truck it may be placed. Thus the truck may be used for almost any purpose, a full load being ensured in every instance.

It is assumed that the whole of the departments of the factory are upon the ground floor, but even were they not so, any of the methods given could be applied, provided that the upper floor departments were connected with the ground by means of lifts. These are, of course, wholly and solely connections strictly limited in their scope, but making it possible for the upper floor system to be directly connected with that on the ground floor. Where goods have to be conveyed from upper to lower floors, gravity can be used by means of either straight or spiral chutes designed to handle the type of goods for which it is required.

Each method quoted has its uses, but, in the interests of the factory efficiency, it is essential first to install the method which will most effectively cater for the peculiar needs of the factory, and then to ensure that the method installed is being worked to its utmost capacity.

CHAPTER XX

THE INSPECTOR AND HIS DUTIES

THE importance of the Inspection Department is now widely recognized, and there are very few engineering factories at the present time in which this department does not enjoy a certain amount of prominence. As a testing place of workmanship it is generally known, but as an aid to production it is not so widely appreciated, and we cannot do better here than to deal with this latter aspect, with a view to proving that an efficient Inspection Department is an indispensable part of every factory organization.

No one appreciates the value of the Inspection Department more than does the progress man, and yet, ostensibly, the two interests are opposed. The latter exists for the purpose of getting completed work through and out of the factory; the former to ensure that that work is up to standard, and it would seem that there are times when the zeal of the progress man receives a check—when his plans and calculations are rudely shattered—by the insistence of the inspector in connection with that phase of the business which claims his interest. Whilst there are times when the inspector and the progress man must inevitably clash, it must be borne in mind that these differences of opinion are of a temporary character, and with each department understanding and sympathizing with the claims of the other, a common working policy which involves no betrayal of principle on either side is forthcoming.

The Inspection Department in its infancy had to contend with the prejudices of the operator, and these for a time were very formidable. The operator is distrustful of any new departure, and the practical value of the innovation must be proved ere his confidence is forthcoming. The skilled man resented what he considered was a slur upon his capabilities—he was out to prove that his experience was infinitely greater than that of the man deputed to examine his work; and if by chance work was returned to him as not being up to standard, he considered it in the light of a personal affront and was prepared to argue accordingly.

The writer has lively recollections of the institution of the

Inspection Department in more than one engineering factory, and instances of bitter opposition are many. One turner—a highly skilled man—was exceedingly bitter at the thought of *his* work undergoing an examination. Was it likely that after his long association with that specific work he would make a mistake? He conceded that it was, perhaps, desirable that the work of the unskilled man should be subjected to an examination, although he could not explain how an Inspection Department could work in such circumstances. He was considerably startled when, shortly afterwards, a slight error was detected which necessitated the return of some of his work for rectification, but he was honest enough to admit his fault, and to express his conversion to the idea that, however good a man may be, he is not infallible, and that a discrepancy is the more easily detected by a person specializing in that direction.

In another instance the operator (an assembler) roundly abused the inspector for daring to dismantle an assembled unit, and detecting a fault necessitating the return of the work to the operator. This man recognized the need for the inspection of machined parts, as having a beneficial effect upon his own earnings, but he resented the procedure being extended to assembled work. Many instances are on record of operators flatly refusing to rectify work turned back by the inspector, and even leaving the firm's employ as a protest. Happily, such cases are becoming less frequent, and it is significant that once the Inspection Department is established it rarely succumbs to opposition.

The opposition of the operator is (or has been) formidable, but it is usually short lived, for he is open to reason once he can understand the import of the innovation. Unfortunately, this cannot be said of the average foreman, who sees in the person of the inspector the department critic, to be treated as an antagonist. The opposition here is covert but sustained, and even in factories where the Inspection Department has been long established the feud between the department foreman and the inspector is as bitter as ever. This may not be altogether the fault of the foreman, for want of tact on the part of the inspector often causes trouble. To illustrate this the writer recalls an incident wherein the findings of the inspector were calculated to create a rupture. A large number of small threaded pins were rejected with good cause

The things were hopeless for passing into stock, but it was proved that the fault lay with the machine and not with the operator. The inspector emphasized this upon his report, stating "fault of machine," and had he finished there, all would have been well. Instead of so doing, however, he added the words, "which needs overhauling," and this was promptly challenged by the foreman. He was undoubtedly correct in his opinion, but he had gone too far. "Had this been the fault of the workman," questioned the foreman, "you would have endorsed your report 'Fault of operator'?" "Certainly," agreed the inspector. "But," continued the foreman, "you would not have added the words 'who should be discharged.'" The inspector could not see the force of the argument, but the management could, and an instruction was issued to the effect that, although it was the duty of the inspector to allocate the fault and under certain conditions to suggest a remedy, it was not part of his duty to make recommendations amounting to an instruction of a character likely to interfere with the authority of a foreman.

The foreman is, however, largely to blame for the friction which exists between his department and the inspector, for he will ofttimes go out of his way to create trouble. One foreman thought it would be a good plan to "kill" the newly formed Inspection Department by inundating it with work of an inferior quality, the greater part of which was unusable until rectified. His idea was that, owing to the extra work involved in the Inspection Department, serious delays would occur, resulting in the management having either to increase considerably the personnel of this department (involving additional expense quite disproportionate to the benefits obtained) or to demolish the department. Needless to say, the foreman burnt his own fingers severely, for the inspector, seeing through the plot, inspected one or two articles only of each batch, and finding these not up to standard, returned the whole batch for rectification. Reports were sent to the management, an inquiry was held, and the foreman was informed that his percentage of defective work was far too high and must be reduced.

As in the case of every other phase of the factory organization, the Inspection Department, to be effective, must be thorough. It is of no use developing one part if the other is to be neglected, and the following may serve to illustrate this point. The inspector

in a certain factory was concerned with the examination of machining and assembling operations, but the raw material used in this connection was received into the factory and issued to the shops uninspected. The result was that at a later stage (in some instances) serious defects in the material were discovered, and the part upon which so much money had been spent was scrapped. In addition to the expense incurred, in regard to both the defective piece and also the replacement, the delay involved was considerable, and the whole would have been obviated had the inspection been thorough—the raw material receiving the same attention at the hands of the inspector as the machined article.

One factor, the importance of which cannot be over-estimated, is the status enjoyed by the inspector, and in this connection it will be necessary to consider the composition of the Inspection Department in various factories. It may be taken for granted that the larger the factory the more important this department is. The chief inspector ranks amongst the highest of the shop officials, and he is usually on a higher plane than the most exalted department foreman. He has an inspection room in every productive department, presided over by a man who is at least on a footing with the department underforeman, and this man is subservient to the authority of his chief, and not to that of any other person. This may be considered an ideal arrangement, and is, on the whole, quite satisfactory, though trouble does occasionally arise, and it is in this connection that the status of the chief inspector must be clearly defined.

In the large factory there is usually a Management Board, that is, a number of high officials who may be said to "run the concern." The composition of this board varies in different factories, but generally each functional division is represented and all are responsible to the general manager who may also be the managing director. Thus there may be a general manager, a commercial manager, a technical manager or chief engineer, a works manager and a chief accountant who may also be the secretary of the company. (See Fig. 39.) In the smaller factory, for economic reasons, two or more of these functions may be merged, thus the works manager may be the supreme head, combining the functions of general manager, technical manager, and works manager. The point in question here, however, is where does the Inspection Department fit in?

If, as in some larger factories, the chief inspector has a seat on the Management Board, then the position is quite clear: his responsibility is clearly defined (see Fig. 39), and his decisions can be overruled by none save the general manager—the supreme head. The department foreman must submit to his ruling, and any protest must be voiced by the chief foreman (who, however, cannot overrule any such decision), and the verdict given by the works manager.

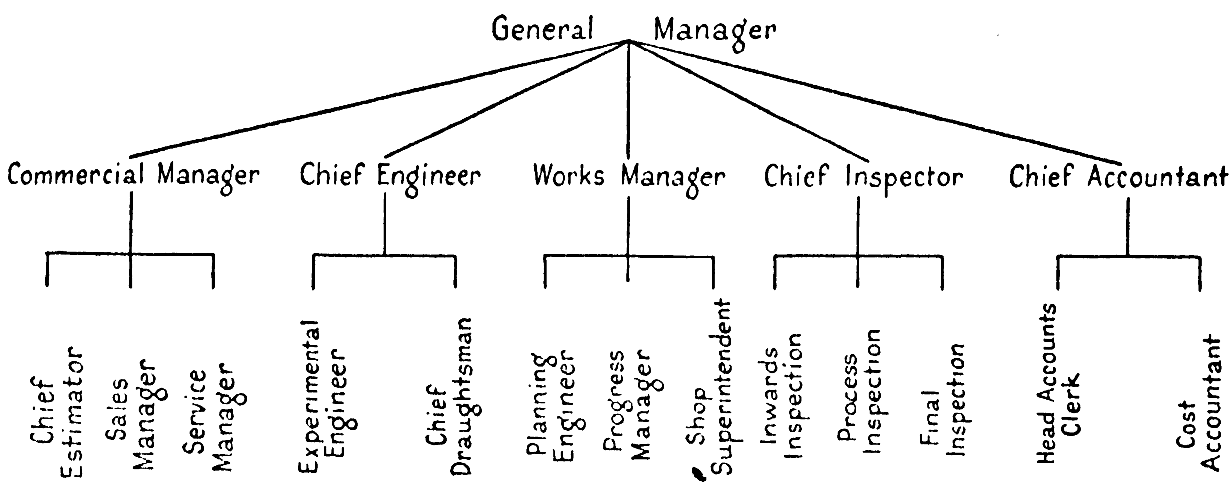


Fig. 39

The Status of the Chief Inspector in the Large Factory

In such circumstances protests would arise only in very exceptional cases, for the high position enjoyed by the chief inspector would be sufficient to guard against constant and frivolous protests.

It does not follow, however, that in every factory the chief inspector has a seat upon the Management Board, and it is in this connection that complications arise. When this is the case, he enjoys a position of the same status as that of the departmental foreman, and he must therefore be under the control of one member of the Board. The question is—which? And the answer has a vital bearing upon the efficiency of the Inspection Department. It may be that the chief foreman exercises control over the whole of the productive departments—that is to say, that whilst not concerning himself with the internal organization of any specific department, he nevertheless is responsible for the well-being of these departments as a whole—the departmental foremen acting as his deputies so far as their own departments are concerned—whilst he may be considered in the light of a production manager.

In many factories it is thought that, owing to the close association of the Inspection Department with the Productive Departments,

the chief foreman should exercise control over this department also. Such a procedure would, to say the least, lend itself to differences of opinion, as the chief foreman would be called upon perpetually to settle disputes arising out of the inspector's rulings, for the department foreman would obviously seize every opportunity of challenging the decision of the inspector with a view to getting it reversed. This in itself is bad enough, involving as it does an enormous waste of time and stimulating bad feeling between the foreman and the inspector, but experience has shown that such a procedure leads to infinitely worse results which materially and adversely affect the whole organization.

To appreciate this it is necessary to consider briefly the respective functions of the chief foreman and the inspector. The former is responsible for the product—the latter for the examination of that product. A piece produced and accepted justifies the time spent upon it—a piece produced and rejected does not, and the chief foreman, as production manager, must regard inspection as a factor calculated to have an adverse effect upon his schemes. He may be a broad-minded individual, and indignantly refute any suggestion of leaning toward the shops, but it is safe to assume that, no matter how unbiased his attentions may be, his actions are decidedly partisan, for he is drawn into the web despite himself. His foremen drag him into controversy at every opportunity—that is to say, when the inspector's ruling permits of argument, and, thinking of production, he will decide against the inspector whenever possible. True, he will agree with the inspector to a point, and will probably administer a slight rebuke to the protesting foreman, but "in the special circumstances" he has decided that the part must pass inspection.

This line of action suggests to the inspector that everything but the actually obvious is liable to be challenged, consequently he evades responsibility by refusing to give a decision in certain instances until he has been in consultation with the chief foreman. This increases the work of that individual very considerably, and is certainly not conducive to efficient organization. With this foreman and that foreman lodging complaints, and the inspector bringing counteractions against the foremen, it would seem that none of them had a sense of responsibility, and may therefore be regarded as somewhat superfluous.

Apart from this, it is certainly most undesirable for the work of the inspector to be supervised by the chief foreman, for this really means shop control, and therefore defeats the object for which the Inspection Department was established. As, however, the inspector must be responsible to one member of the Management Board, the claims of the technical manager or chief engineer in this connection may next be considered. This procedure would, at all events, ensure an Inspection Department free from the control of the shops, but much depends upon what sphere of the organization is controlled by the chief engineer. He may be concerned wholly and solely with the plant, and known in some factories as the mechanical superintendent, and if so, then obviously he cannot be concerned with the inspection of the factory's products. If, on the other hand, his responsibility is the design of the factory's products, then it would be quite possible for his control to extend to inspection, and this has proved satisfactory in several medium-size organizations. In some factories the question of the inspector being controlled by the Planning or Progress Departments has received consideration, but this still means that the chief inspector is responsible to the works manager. To put the case in a nutshell, the Inspection Department should be independent, the chief inspector having a seat on the Management Board, but where economic considerations rule this out the department should never be controlled by any person responsible for production. Hence it is that in many medium-size factories the Inspection Department is under the control of the chief engineer who is technically competent and can be relied upon to effect the necessary balance between the company's and the customer's interests. (See Fig. 40.)

In the smaller factory, also, the status of the inspector must receive consideration, and in this connection it must be borne in mind that, whereas the large concern can secure the services of a really responsible person for the position of chief inspector, this is not always possible in the smaller factory. The inspector who is prepared to accept full responsibility, whose word is accepted as law, must of necessity be a really first-class man, capable of doing what he is called upon to perform. This means that the post is occupied by a high salaried official, whose remuneration is probably as high as that of the assistant works manager in a small factory. It is obvious, therefore, that the smaller concern must content

itself with the services of a less imposing individual, and it may be that in such circumstances the inspector is not qualified to have the final word.

In such a factory there is no recognized Management Board, but the works manager has the assistance of shop superintendents, who control the various section foremen, and again the question arises "Should the inspector be controlled by any or all these

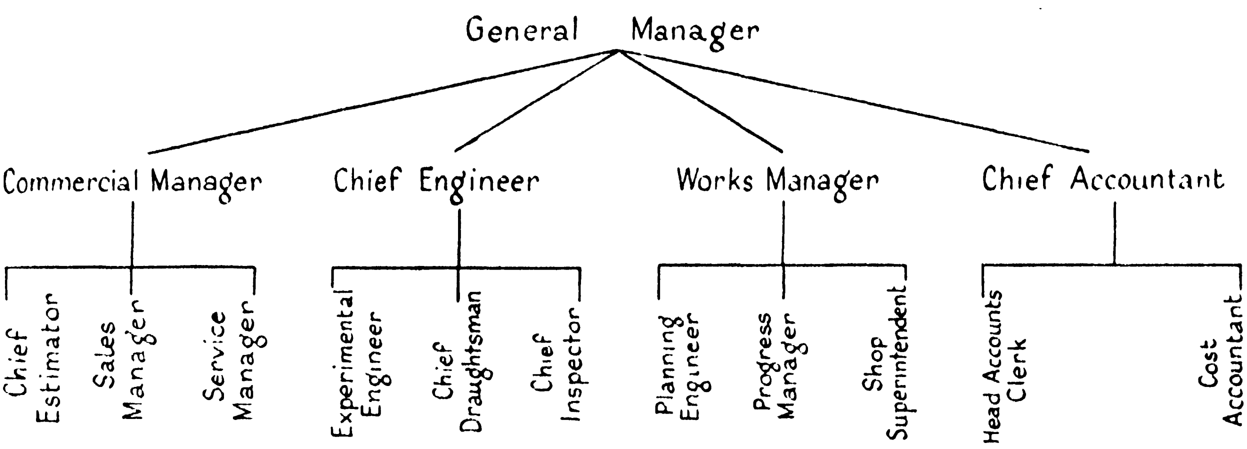


FIG. 40

THE STATUS OF THE CHIEF INSPECTOR IN THE MEDIUM FACTORY

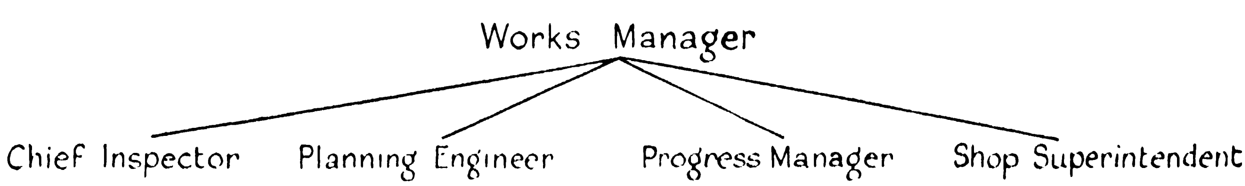


FIG. 40A.

THE STATUS OF THE CHIEF INSPECTOR IN THE SMALL FACTORY

superintendents?" It is, admittedly, risky in these circumstances to allow the final decision to rest with the inspector, for there is a distinct possibility of hundreds of pounds of usable work being put on the scrap heap. On the other hand, the influence of the superintendent may result in a lot of doubtful work being accepted, the inspector being regarded as a mere cipher. The efficiency of the Inspection Department would be of a very mediocre character, for the inspector would be guided by the superintendent, possessing no authority and undertaking no responsibility. In one factory the inspector was allowed to reject work, but he was obliged to consult with the shop superintendent before the work could be definitely scrapped. This could not be regarded as satisfactory, for the final decision rested with the individual officially responsible for the defective work.

Where the factory is so small that the works manager's responsibility extends beyond production interest only, he may then control inspection. But, it must be a cardinal principle that the chief inspector ranks equal in status with the chiefs of Planning, Progress, and Production. By this means only can the chief inspector have freedom from intimidation, and in the event of protest have the satisfaction of stating his case to a less prejudiced person than those immediately responsible for the defect or failure to produce. The ideal to be aimed at is to have independent status for the chief inspector. Figs. 39, 40, and 40A show how this principle is related to the economies of large, medium, and small concerns.

CHAPTER XXI

A SYSTEM OF INSPECTION

THE productive value of the Inspection Department is not to be despised, for it can and does exert a wonderful influence. Inspection ensures high grade workmanship, and this is reflected in the sales; whilst in the factory it plays an important part in facilitating production and increasing output. It is no longer the "retarding department" of bygone days when, owing to inefficient organization and the mass of opposition encountered, it seemingly did nothing but frustrate the efforts of those concerned with production, either by passing through work of an obviously low standard or by returning work on account of technical inaccuracies without regard to the circumstances in which the work would be used.

To-day the process is reversed. The inspector has a sympathetic understanding of the functions of every specific piece, and technical inaccuracies are overlooked in favour of practical utility. Low standard machining is not now allowed to cause trouble and delay in the assembling shop; and the fact that an hour or so longer is necessary in the machine shop to bring work up to the standard does not stamp the Inspection Department as a "retarding department" but rather as a productive department, inasmuch as a certain decision ultimately means time saved.

As emphasized in the previous chapter, however, the inspection to be effective must be thorough; and, apart from thoroughness in regard to operations of work in progress, it must be applied to everything entering and leaving the factory. Just as it is of no use inspecting an assembled unit to find defects in the machining of the component parts, so also it is of no use to inspect a machined part to discover defects in the material. Inspection must start at the very beginning and continue right through until the completed article is ready for dispatch.

It is proposed to set forth in this chapter what may be described as a real, live inspection organization, which may be applied with success in practically any engineering factory. The principle is "inspection of *everything*," and by its application it is almost

impossible for anything, no matter how small or apparently unimportant, to be neglected. It is comprehensive, and at the same time simple, for the factory is divided in such a way as to allow the inspection of a specific article to be performed by an expert.

The Inspection Department proper is concerned with production, and is therefore responsible for the inspection of every piece actually used in the assembly of the unit. Speaking broadly, the department must examine and pass (1) raw materials (castings, forgings, pressings, bar material, sheet material, etc.); (2) machining operations; (3) finished parts purchased from outside sources; (4) sub-assemblies; (5) final erection; and (6) loose accessories. It is proposed to deal with these in rotation.

Raw Materials

(1) It is essential that all raw materials are examined and certified as in order before any operation is performed. In the case of castings and forgings, of course, an operation has been necessary to bring them into existence; but, to all intents and purposes, they fall within the category of "raw materials." In the factory where the volume of work justifies it, special inspectors are in charge of castings and forgings; and it is their business to check the parts with the dimensions given upon the drawing to know whether sufficient material is available for machining, and to ensure that no flaw or defect exists. It is not part of the machining inspector's duty to look for any of these defects. He has the right to assume that the casting or forging, when it reaches him, is correct in every detail, so far as external observation is concerned.

Bar material must be inspected immediately upon receipt into the factory, and for this to be done effectively the inspector must have a copy of the Purchasing Department's requisition, so that he may be conversant with the terms of the order in regard to quality and accuracy. In one case, ordinary commercial bar may be ordered, and this may be accepted within wide limits; whilst, in another case, bar is ordered which must be accurate to one thousandth part of an inch in diameter. It will thus be seen that for the inspector to discriminate he must know exactly what has been ordered, and it is obvious that a carbon copy of the actual requisition is the best medium for ensuring this.

Apart from the inspection of dimensions, the material must be

examined for flaws and other superficial defects, such as defacements, etc.; and then it should be tested for quality. This may, perhaps, be unnecessary in the case of ordinary commercial bar; but when material is ordered for a particular purpose, necessitating a specific tensile strength, the rest is absolutely essential. Sheet metal must be gauged and examined for flaws and other defects; and in some cases it is necessary to test the texture of the material, as it may be too hard or too soft for the purpose for which it was ordered. The inspector must know the particular part or parts for which the material is intended, and here again the copy of the Purchasing Department's requisition furnishes the desired information.

It must be borne in mind that an inspector's function is to ensure the correct quality standard with the least hindrance to production. The sensible inspector of raw materials will look out for such defects as will hinder production as well as for functional defects. Thus he may find that a "riser" on a casting is in such a position that it will prevent true location of the casting in the drill jig and thereby cause scrap. He will report this to the Buying Office so that corrective action can be taken at the foundry, and will arrange with the Planning Department for a temporary extra operation to remove the excess metal on all the castings already delivered. He must also check that materials delivered are to the correct specification, and this may call for metallurgical examination for which he or his chief must be in a position to arrange.

Machining Operations

(2) The inspection of machining operations is a most necessary proceeding, and unless this is performed expeditiously, delay is inevitable and production consequently retarded. At the same time, it must be borne in mind that inspection cannot be rushed, for the result would defeat the object for which the Inspection Department was brought into existence. Each and every component part must, at the completion of each operation, pass through the inspector's hands; and if the organization is efficient this will be done in a systematic manner, with an entire absence of delay.

In one factory the whole of the details actually pass into the inspecting room after every operation; whilst in another travelling inspectors examine the part whilst actually in process. The procedure in regard to the first method is that in each productive

OPERATOR'S PROCESS CARD

Order No.................... Drawing No.................... No. of Pieces....................
Name of Part..
Tool or Jig No.. Fixture No..
Details of Process..
....
Time allowed..minutes each.

First Pieces completed............................ Quan............... Passed...........................
Sgd. *Foreman.* *Inspector.*

Order Completed............................... Rejects............... Passed...........................
Foreman. *Inspector.*

Received in Store..................................

FIG. 41

department there is an inspecting room, and when the first two or three parts of any specific detail have had the operation completed these, together with the operator's work card, drawing, and jig, are taken to the inspecting room. If these are pronounced correct, the inspector signifies the fact upon the operator's card (or upon an inspector's report slip) and the parts are returned to the operator,

INSPECTOR'S REPORT

Order No.................... Drawing No.................... Date...............................
Name of Part..
Process ....
Operator's Name.. Clock No...................
Number Rejected.................................
Reason ....
Fault of ....
Decision ....
Sgd... Accepted by..
Inspector. *Foreman.*

FIG. 42

who then proceeds with the bulk of the order. If, on the other hand, the parts are incorrect, the inspector specifies what is wrong, and the operator must correct and submit again. In no circumstances should the bulk be proceeded with until the first parts have been approved of and bear the inspector's stamp.

The first parts having passed inspection, the order is proceeded with; and upon completion the whole of the articles enumerated

are sent into the inspecting room, together with the operator's work card. If the whole are passed as correct, the operator's card is endorsed by the inspector, and the articles sent into store or to the section responsible for the next operation. The inspector's signature is the "hall mark," and until this is appended (and the articles stamped) nothing can be accepted either by the store or by another manufacturing section or department, neither can payment be made for the work done.

Where the whole or a part of the articles on an order fail to pass the inspector, that individual must make out a report, setting forth briefly the reasons for failure, and also his decision. Bearing in mind that he has previously passed the first two or three pieces on that order, it is obvious that if the bulk are operated upon in a precisely similar manner, the responsibility rests, not with the operator, but with the inspector; and the onus is, therefore, upon the latter to make absolutely certain that the first pieces are correct in every detail before returning them to the operator. Assuming, however, that the first pieces are correct, and that the bulk are at variance with those first pieces, the inspector will state upon his report what is wrong, whether scrap or rectifiable. If the latter, they are returned to the operator, who must rectify at his own expense; whilst, if scrap, replacements are necessary, in connection with which the operator must be penalized.

The inspector is responsible not only for quality but for quantity, so far as any specific order is concerned. Assuming that the order (or operator's card) covers 100 pieces, that quantity must be accounted for by the inspector. It may not be possible to send the 100 pieces to the store or to the next section, owing to causes beyond his control, but his report must be explicit and may be summarized as follows—

"Number of pieces on order 100. Number passed 85. Number scrapped 5. Number to be rectified 8. Lost in section 2. Total 100."

It must be observed that the inspector is responsible only for the operation specified upon the order or the operator's card; and as one specific article may pass into the inspecting room a number of times (following different operations) it is essential that it is stamped in such a way as to show the inspector what operations have previously been inspected. It must also be borne in mind that the same inspector does not necessarily examine every operation

in connection with the same article, and it is essential that the stamps must fulfil a two-fold purpose—the identification of the inspector and the precise operation passed. To illustrate this more fully, let it be assumed that a certain order covers a part upon which the following operations are necessary: turn, bore, mill, drill. The order enters the inspecting room, in the first instance, for the examination of the turning operation, and this is passed by Jones. This individual has his own set of stamps and he uses the one which will denote the inspection of operation No. 1. The order next enters the inspecting room for the examination of the boring operation, and Roberts undertakes the inspecting. This individual also has his own set of stamps and he uses the one to denote that operation No. 2 has been passed. He notes that operation No. 1 has already been inspected and so he does not worry about that. Now the order comes in for the inspection of the milling operation, and inspector Williams is prepared to use his own stamp to denote that operation No. 3 has been inspected. He finds, however, that something is wrong. He checks the milling carefully; and, although ostensibly everything is in order so far as his own operation is concerned, it is apparent that there is an error somewhere. He therefore checks the preceding operations and discovers a discrepancy in the turning. A glance at the stamp marks will show that inspector Jones passed this operation, and so the matter is referred to this individual for adjustment.

In the factory where the inspection of operations is carried out whilst the work is actually in progress, the mode of procedure is substantially the same. In this case, however, the association of the inspector with the work is much closer, and by periodical inspection it is oft-times possible to detect discrepancies and have these rectified without incurring the delay which is possible where the part is sent to the inspecting room. Which is the better method of inspection is, however, largely a matter of opinion, although special circumstances, such as the class of apparatus manufactured, the lay-out of the shops, and the general factory routine, must be taken into consideration.

Finished Parts from Outside

(3) The inspection of finished parts received from outside suppliers must be in accordance with the conditions under which the order

was placed. Here again, therefore, a copy of the Purchasing Department's requisition is necessary for the inspector, for this will give the exact terms of the order. It may be that a blue print was sent to the supplier, and the part must be inspected with this, the piece being carefully checked and due regard paid to the limits shown on the drawing; whilst, if gauges were sent to the supplier, then, obviously, gauges must be used for checking purposes. The general finish of the piece must be commented upon, and the inspector's report must be intelligently compiled, showing concisely the defects (if any), whether these are detrimental to the piece, and the inspector's decision in regard to them.

Apart from the normal bought-out-finished supplies, it sometimes happens that a firm requires to sub-contract certain machining work, either because its own capacity is inadequate for the load or because it does not possess the type of machine best suited to a particular operation and the amount of such work does not justify the purchase of a machine for the job. In such circumstances this sub-contract machining must be inspected just as carefully as if the operation was carried out within the factory and at the commencement of each new job a sample should be insisted on for approval before the sub-contractor proceeds with bulk. The fact that it is the sub-contractor's responsibility to meet the specified accuracy is beside the point. Insistence on a sample will preclude the waste of time and hold up of output which can occur if a batch is rejected.

Sub-assemblies

(4) Sub-assemblies are inspected from a fitting standpoint, and as one piece. The inspector does not look for machining defects in connection with any part comprising the unit, unless the job is adversely affected by such a cause. The inspector assumes that all the details comprising the assembled unit are correct, seeing that each one has previously passed inspection, and he concentrates, therefore, upon the unit as a whole. The order or operator's work card covers a definite number of sub-assemblies, and these are inspected either in the inspecting room or in the assembling shop, whichever is more convenient, the inspector reporting on these in the same manner as on machining operations.

Final Erection

(5) The inspection of the final erection follows the procedure

adopted in the case of sub-assemblies, i.e. from a fitting or erecting standpoint. When this has been accomplished the unit is ready for dispatch, unless a test (as in the case of electric motors) is necessary. If this is so, then another inspection is necessary after the test.

Loose Accessories

(6) Loose accessories are inspected in accordance with the type of piece involved; that is to say, loose machined parts inspected as other machined components, and assembled parts as the sub-assemblies already referred to. Sometimes, when each set of loose accessories comprises a large number of parts, a general inspection is resorted to just prior to dispatch.

This may be said to complete the range controlled by the Inspection Department proper; but, to ensure an absolutely efficient inspection organization, many other factors must be considered. The inspection of tools is not one whit less important than inspection of actual production parts, but this duty devolves not upon the Inspection Department proper but upon the tool room organization. If the factory is large enough, a Tool Inspection Department is desirable, but in the smaller factory the head of the tool room assumes responsibility.

The inspection of tools may be divided into the following categories: (*a*) raw material (high-speed steels, etc.); (*b*) tools and jigs produced in the factory; and (*c*) small tools (drills, taps, cutters, etc.) purchased from oustide. The following procedure may be adopted for inspection—

(*a*) For tool inspection, the tool room inspector (or chief) must be considered by the Progress and Purchasing Departments as an Inspection Department, and therefore the copy of the Purchasing Department's requisition for tool supplies must be sent to the individual responsible for inspecting. The raw material will be tested and inspected, and, if passed, sent to the Tool Steel Store, an inspector's report being made out as in the case of raw material for production purposes.

(*b*) The inspection of tools, etc., made in the factory will be done at various stages of manufacture, and a final report compiled at the completion of the tool just prior to its receipt into the tool store. As in the case of production parts, no tool should be accepted into store until the inspector's report is forthcoming.

(*c*) Drills, taps, cutters, etc., received from outside should be submitted to the tool inspector, the copy of the requisition being again necessary. Although the goods may be standard parts, it may be that those received, though correct as regards quality, are nevertheless not in accordance with the order. A batch of No. 30 drills may have been ordered and No. 31 drills received, and it is just as important that the goods are accepted strictly in accordance with the order as that the quality is in accordance with the standard demanded.

Other Factors

This disposes of the tool inspection, but there are other factors to be considered before it can be said that the factory inspection organization is complete. New machines, machine parts, machine belting, etc., must be inspected by the person best qualified, who in this case is the works engineer, or head millwright; whilst lamps,

INSPECTION CLASSIFICATION

Classification No.	Name	Particulars	Inspection
1	Manufacture	All raw material, castings, forgings, stampings, bar and sheet metal. Finished or partially finished parts used for actual manufacture	Main Inspection.
2	Tools	All high-speed steels, cast steels, castings and other material used in connection with tools, jigs, etc. Small tools, taps, dies, drills, cutters, files, etc. .	Tool Inspector.
3	Plant	All machine tools and appurtenances thereto. Belting, replacements, etc. .	Millwright.
4	Electrical	All lamps, cables, fittings, motors and motor details	Electrician.
5	Sundries	(*a*) Standard, i.e. cotton waste, emery, etc. . . (*b*) Specialities, i.e. polishing and plating details, etc.	(*a*) Storekeeper. (*b*) Plating Foreman.

FIG. 43

REQUISITION

FROM H. C. BLANK & Co., LTD.,
5 Mill Street,
LONDON.

TO MESSRS. BROWN, LTD.,
NEWCASTLE.
20th August, 19....

Please supply the following—

Quantity	Particulars	
2000	Frame castings to our Pattern number 5468 sent you to-day . . . . @	50s. per cwt.
	As per your quotation of the 10th inst.	Carriage Paid.

Terms 2½% monthly.

Delivery Commence 2 weeks.
Complete 6 weeks.

Signed......................*AB*......................
for H. C. Blank & Co., Ltd.

(Front)

INSPECTOR'S REPORT

On Parts Received against Requisition Overleaf

Date	Name of Part	Drawing or Pattern No.	Number Received	Passed	Rejected	To be Rectified	Inspector	Particulars of Report	Received in Store No.	Received in Store Sig.
3/9/.	Frames . .	5468	371	365	6	—	H.	6 Blowholes	365	W.
8/9/..	Frames . .	5468	415	415	—	—	H.	—	415	W.

(Back)

FIG. 44

cables, and other electrical fittings are submitted to the electrician before being accepted into store. The individual responsible must report in exactly the same way as the production inspector, and it should be a hard-and-fast rule that no material of any description must be accepted as correct unless the fact is made apparent through the medium of an inspector's report.

Sundries, such as emery cloth, waste, wipers, etc., should be inspected before acceptance by the chief storekeeper, for even with these articles it is possible to get a consignment of an inferior quality at a relatively high cost. Special sundries, required to meet the peculiar needs of the factory, must be inspected by a competent person. In this category appear the requirements of the plater (powder, acids, anodes, etc.) and the polisher (emery wheels, discs, mops, bobs, etc.), and the inspection of such parts should be undertaken by the foreman of the department interested. In some instances it may not be possible for a definite report to be issued, in regard to quality and utility, immediately the goods are received, for the practical value of the commodity is demonstrated by use. The primary inspection, therefore, consists in the main of checking to order; and the foreman may, at a later date, supplement his report as a result of practical experience, and so influence the Purchasing Department in respect of future orders.

This may be said to complete the inspection organization, and all that remains now is to show the method by which the outside supplies are handed to the person responsible for inspection. It is essential that no delay or confusion arises through a consignment of parts being sent to the wrong person, so to obviate this all material purchased from outside sources is classified and tabulated in the Purchasing Department in the manner shown.

The purchasing requisition is made out in triplicate, the first copy going to the supplier, the second being retained in the Purchasing Department, and the third also held temporarily in the same department and being released upon receipt of an advice note showing that goods have been dispatched. The reverse side of the third copy may be used by the inspector for the purpose of making his report, as shown on page 152, which gives the face and reverse side of the requisition. This is referred to in some detail in the section devoted to purchasing, but the foregoing will show how comprehensive the inspection is when handled on the lines advocated.

CHAPTER XXII

PROGRESSIVE PURCHASING

PURCHASING, as a part of the progress organization, may be said to strike a somewhat new note, for the factories in which this is practised are by no means numerous, whilst even those which have so far advanced have, in a majority of cases, failed to grasp the real significance of the innovation, and, as a consequence, have not reaped the maximum results. How these can be achieved it is the aim of the writer to demonstrate in this chapter.

In many factories the Purchasing Department is not under works control, being usually associated with the commercial section. This has the effect of rendering the department somewhat isolated which, considering the fact that its activities are wholly of interest to the works, is not altogether desirable. It may be that this is a very effective safeguard, being a check upon exorbitant or unpracticable demands of the works, and no doubt, in days gone by, this factor had to be taken into account.

Finance is closely bound up with the Purchasing Department, and it is a very easy matter for the firm to be involved in heavy losses. Thus it is that the commercial man, rather than the engineer, is entrusted with the control of this department—the man who has no direct interest in the proposed purchase, and who will in all cases consider the financial liability before anything else.

In the case of standard purchases for stock, these are always predetermined, and a notification from the storekeeper to the effect that certain stocks are down to the minimum figure will ensure further supplies being ordered, whilst in the case of special parts, which for obvious reasons cannot be produced in the factory, these, too, are placed on order as a matter of course. Between these two extremes, however, appear the cases which really count, and it is these which test the Purchasing Department.

It is the contention of the writer that the Purchasing Department must be closely associated with the works—that it must understand what is being purchased and why it is being purchased, and further, to a very great extent, must determine what shall be purchased.

This last phrase may give rise to some comment and will certainly need explaining, but it is well to take a strong line in order to prove an assertion. It is in this connection that purchasing must form part of the progress organization, for in order to determine what shall be, or what shall not be, an intimate knowledge of the circumstances is essential.

The progress organization obviously is not complete if one of its limbs is missing, and purchasing is emphatically one of the limbs. The strong and efficient organization carries no passengers—there are no people who do just what they are told, and have to be instructed in every move. The storekeeper touches the button and the requisite standard parts are ordered. The engineer or the planner decides that a certain part must be placed outside, and this is attended to. But where does the buyer come in? So far the work can be handled by a clerk!

"But," it will be observed, "he buys." He is the man who must know the markets—who knows where to buy to the best advantage. This is well so far as it goes, but for a moment we will consider what is meant by buying to the best advantage. The man in the isolated Purchasing Department views this in the light of low price, and by getting material a few shillings below the price paid before he feels he should be congratulated. He does not know, however, what the effect will be in the factory—whether that "cheap" material will in reality develop into a cheap finished product.

Let us take one or two examples. He has, in the past, bought sheet iron at a certain price, and upon this material the standard of operations has been fixed. In course of time it is necessary to re-order, but he does not consider himself compelled to place a repeat order with the same supplier. He is out to do better, and eventually he is offered material at a price several pounds per ton less. He closes with this, thinking he has done a good stroke of business, only to find a little later on that so far from saving a few pounds he has, in reality, lost still more. The material was not so good for the purpose for which it was intended, at all events, and to make it suitable extra operations are necessary which involve additional expense.

In another case, he may be buying glue. In the past he bought this at a certain figure, but he yields to the temptation to get some at a lower figure. He probably saves a few shillings on the deal,

but in the shops the purchase does not give satisfaction, and orders for glue become more frequent, 3 cwt. of the inferior quality being necessary to do the work for which, in the past, 2 cwt. had been quite sufficient.

It is safe to say that had the buyer been conversant with shop conditions he would have endeavoured to cater for those conditions, and not put first cost above everything. It is certain that the isolated buyer thinks only of his own department, and he goes out to show that his department is wide-awake, demonstrating the fact by means of reduced prices. Says he in effect to the shops, "I am reducing costs by purchasing cheaply, and have effected a saving of hundreds of pounds. If the shops can show a similar saving, then the firm benefits."

As a matter of fact, it is he who prevents a saving in the shops—indeed, he is increasing costs in that direction. If he could buy a better quality material at the cheaper rate, he would give the shops the opportunity of likewise reducing costs but, knowing nothing about the shops, he fails to see this, and the "saving" is of the negative variety.

Being away from the shops, the buyer misses many opportunities to shine. To take the case of the standard materials, he cannot order until authorized to do so by the storekeeper, and when the authority is received he must order at once. How, then, can he take advantage of the market. Last week he could have purchased a certain section of steel at a certain price, but he was unable to take advantage of it because he had no authority to order. This week the authority is to hand but that particular consignment of steel has gone, and he must now pay two or three pounds per ton extra. He cannot wait a week or two in the hope of snapping up something at a lower figure, and so, perforce, he must place his order to the best advantage.

In the matter of purchases other than standard, the buyer must be governed by the decision of the engineer or the Planning Department. In regard to the former this is not a big point, for usually it is only the obvious that is placed outside. If the goods are made of rubber, or vulcanite or similar material, these, of course, cannot be produced by the average engineering factory, the same remarks applying to specialities identified with a certain firm, such as balls, ball bearings etc. Requisitions for these arrive in the Purchasing

Department as a matter of course, and the orders are placed upon the firms associated with the commodity without comment.

Regarding the Planning Department, however, the matter is somewhat different. In the section devoted to planning, it is suggested that, upon receipt of a new drawing covering a certain part, the planner determined the processes necessary, and also whether the work could be done in the factory. There can be no quarrel at his decision not to do work in the factory so far as the buyer is concerned, for obviously the man in charge of the planning and process fixing is the authority on such a matter, and his ruling in this respect can be set aside only by the works manager.

But it is when the planner decides that work *shall* be done in the factory that the buyer should be interested, though, if the Purchasing Department is remote from the shops, this is an impossibility. In such circumstances the buyer cannot evince any interest in the concerns of the shop, and merely does as he is told. But if the Purchasing Department is part of the progress organization, the chief buyer, as progress manager—having a direct and active interest in the movements of the shops—can put the shops into competition with the outside supplier.

The advantages which accrue from this are many, for a wholesome influence is exerted over the shop organization. It puts the production officials (the planner, shop foremen, and the like) on their mettle, for they realize that unless they can produce at a competitive price they will not get the work. It may be argued that this would have the effect of impoverishing the shops, but experience teaches otherwise. No buyer would allow any outside firm to obtain a monopoly of any specific supply if he could possibly help it. He encourages competition with a view to obtaining the best value possible, and the outside firms know it. If the buyer is keen in this direction, and yet allows his own shops to monopolize certain products, then he fails to achieve the maximum results, and he is not doing his job efficiently.

The firm naturally desires to keep as much money as possible inside the factory, and nothing is placed outside which can be produced more economically inside. This is obviously sane policy, but who determines the economic standpoint? The planner definitely states that he cannot produce a certain part economically, and so it is produced outside. On the other hand, he accepts

another part for production, but can he determine whether he can produce this as economically as an outside firm?

The buyer alone can determine this, by reason of close association with both the shops and the outside firms. Remote from the shops, the question does not arise, but, associated with the shops, concerned with output and the facilities to ensure this, he recognizes that the outside firm can beat his own shops, unless the latter can produce more cheaply.

The progress manager must control the buying, and this brings the Purchasing Department into direct association with the shops. Modern organization readily permits of this, and at the same time obviates the objection to factory control. Administration is distinct from production, and the progress manager, providing the facilities necessary to ensure economic production, cannot afford to allow such a vital factor as purchasing to escape him. No one knows better what is required, and it is up to him to get it. He must take the initiative and he must look ahead.

He has a double advantage, for he knows the state of the stocks, the commitments of the firm, and also the position of the market. He knows what to buy and when to buy, and he does not have to await instructions. As a buyer he is out for value for money, but as a progress man he recognizes that a low first cost may ultimately prove an expensive bargain. Associated with the shops, he knows what material will be beneficial to production, and he purchases accordingly. He gives the shops every opportunity, and if he can purchase outside to better advantage he says so, at the same time inviting the shops to compete. On the other hand, he is prepared for the shops to take in hand any part which has habitually been placed outside, and he will invite them to compete.

This is not a theoretical suggestion but a practical proposition, for such a purchasing and progress organization is in existence. For years the writer has laboured with this end in view, but the Purchasing Department has been inaccessible. Buying is not efficient without factory association, and progress is not complete without purchasing control. With the two departments separate and apart there is a loose end, but this is picked up by amalgamation. That the engineer benefits by this arrangement will be shown in the following chapter, for the decision of the inspector determines the policy of the buyer.

CHAPTER XXIII

SATISFYING THE REQUIREMENTS OF THE ENGINEER

HAVING accepted the principle outlined in the preceding chapter, we may now consider the working of the Purchasing Department. It will readily be conceded that, purchasing forming part of the progress organization, the activities of that department are considerably extended, and the viewpoint of the shops receives due consideration.

It is not good policy to ignore the opinions of the shops, although it by no means follows that every demand is acceded to. The independence of the Purchasing Department, so far as shop control is concerned, must be accepted by those in authority, and, if this is generally recognized and no attempt at intimidation is made, it will be found that the shops benefit to no inconsiderable extent.

In the section devoted to inspection, reference is made to the duties of the inspector in connection with goods received from outside sources, and as nothing can be accepted into the factory until it has been through the inspector's hands, it will be seen that the opinions of the engineer cannot be ignored. In other words, although the shops cannot dictate to the Purchasing Department in respect to ordering, they can at all events refuse the goods provided, although obviously there must be good reasons for so doing. Still, the fact that goods can be thrown back upon the buyer must influence the policy of the Purchasing Department, otherwise the efficiency of the department would speedily be open to question.

The inspector's report must not be frivolous, and the inspector must be prepared to substantiate what he has written. His report is without bias and is dictated solely by a sense of his obligations. He inspects to a specification, and if the goods are not in accordance with that specification he says so. It does not follow, however, that the goods are necessarily rejected, for the inspector has discretionary powers, and, despite a technical inaccuracy, the goods in question are quite usable. He is insistent, however, that goods must be purchased in accordance with the specification, and upon

his report he draws the attention of the buyer to the inaccuracy, and the buyer, like a wise man, passes the information to the supplier.

In another case a certain amount of doubt exists as to the wisdom of accepting goods which are not accurate, and the ultimate decision depends upon circumstances. The inspector in this case would issue his report but would not give a decision. It then becomes a matter for the chief inspector, who acts in conjunction with the progress manager, and the decision is put in writing upon the report and signed by the chief inspector. If, at a future date, trouble is experienced the inspector is able to clear himself, the responsibility resting with his chief.

There are times, when the inspector issues an adverse report and definitely rejects the goods, that the decision is directly challenged by the progress manager. Not that he considers that the inspector has been guilty of an error of judgment—for that is not within his province—but as a matter of expediency. And this is another case where the progress manager shines as the buyer. Harking back once again to the supposition that the Purchasing Department is remote from the shops, but assuming that the buyer is influenced by the inspector's report, he must, in practically every instance, act in accordance with that report.

The inspector's decision is that a certain consignment of goods shall be returned to the supplier as not being in accordance with specification, stating his reasons for the decision arrived at. The buyer may challenge this but only from a buyer's standpoint, which means that he is pitting his judgment against that of the inspector—he considering that he has got a satisfactory article, whilst the inspector takes a contrary view. Now, with all respect to the buyer (and as a buyer the writer knows what he is talking about), he cannot be possessed of knowledge equal to that of the inspector. The buyer may consider that he has bought a good article, and no doubt he has, but it is the inspector who knows whether that article, good as it is, is suitable for factory use.

The buyer caters for the needs of the factory, and the inspector determines whether he has satisfied those needs or not. If a housewife orders a three-pint kettle, and the shopkeeper sends in a two-pint, it is of no use the latter protesting that what he sent was a really good article. In all probability it was, but not being what

was required it did not satisfy the need, and was therefore useless so far as that purchase was concerned.

It is a wrong policy for the buyer to challenge the inspector from a utility standpoint, and as the intelligent buyer recognizes this, we will assume that he accepts the inspector's ruling, and returns the goods. In so doing, however, he does not consider what the effect will be so far as manufacturing is concerned. He has no direct interest in the shops—it is not his business to question the ruling of the inspector—and, in any case, whatever happens, he is covered.

The inspector is similarly situated, even though he is in the shops, for his duties are clearly defined. He is there to inspect goods—not to manufacture them—and it is his responsibility to ensure that everything he passes conforms to the specification. Should he fail to do this, then his position as an inspector is abortive. It is true that he has discretionary powers, but these are used solely in regard to the merits of the goods—that is to say, although not absolutely up to standard, the inaccuracies are so minute that the goods are really usable. Beyond that point he does not go. He knows nothing of the state of the stocks—he does not know that a certain job is practically waiting for those very goods—and if he did it would make no difference. It is not his business, and so the goods are rejected and returned, and work in the factory is delayed in consequence.

But when the progress manager controls the Purchasing Department a different state of affairs exists, for he knows better than anyone else what the effect will be. It is his business to know, for his duty is to facilitate production by providing adequate supplies of material. So when a consignment of goods is rejected by the inspector, the progress manager's first thought is of the effect that rejection will have upon the shops. It may be that the state of the stock permits of rejection, in which case the inspector's ruling is accepted without comment.

On the other hand. rejection may result in serious trouble, and the progress manager, recognizing this, does all in his power to obviate or, at least, to minimize it. He cannot over-rule the inspector's decision, but he can challenge it—not (as before explained) on its merits, but on the score of expediency. He takes up the matter with the chief inspector, and lets this individual

see what the effect will be if rejection is insisted upon. If the goods are such as to be absolutely unsuitable—that in no circumstances can they be used—then the inspector's decision is endorsed by his chief, and the progress manager must perforce submit to this ruling, and seek to minimize the trouble entailed by getting replacements with as little delay as possible, or by arranging (if practicable) to produce a limited number of the parts in the shop.

Where an element of doubt appears, however, he presses his point to the uttermost, and the chief inspector must face his task with a sense of deep responsibility. There is no doubt that, if serious trouble is occasioned by the rejection, the matter will not lightly be disposed of, for the management will undoubtedly insist upon a most searching inquiry. The progress manager will show what efforts he has made, and the onus is upon the chief inspector to prove that the decision arrived at is unassailable. It is evident, therefore, that the latter will do all possible to meet the claims of the progress manager, and he will not be disposed to treat the matter lightly. This conduces to efficiency in regard to inspection, progress and purchasing, which means good value for the firm, whilst the supplier is satisfied that he too is receiving justice.

As before suggested, the chief inspector approaches the matter with due regard to the specific circumstances, and a reversal of the inspector's decision by his chief casts no reflection upon the judgment or the capabilities of the former. The chief may make a decision on the following lines, viz.: (*a*) accepting the whole consignment under protest, stating clearly the circumstances which impelled him to accept, and emphasizing the necessity for the Purchasing Department to set the facts before the supplier. In this case also the chief inspector may insist upon the buyer supplying him with a copy of the letter sent to the supplier, embodying his remarks; (*b*) accepting a small part of the consignment to meet the present contingency, but insisting upon the rejection of the major portion; and (*c*) accepting the whole (or part) provided that the goods are rectified in the shops in accordance with his instructions. In this case the onus is upon the progress manager to determine who shall bear the cost of rectification—whether this shall be charged to the supplier or to the progress organization.

Whilst it is true that any inspector's report may be challenged at the instance of the progress manager, it may be taken for granted

that this individual will not attempt the impossible. If the report is intelligently compiled, he is able to discern where his intervention is likely to lead to success, and it is upon such cases that he concentrates. At the same time he, too, must have a strong case, and he must justify his action in challenging the inspector's decision. It will be seen, therefore, that strong grounds must exist for any action on the part of both the chief inspector and the progress manager.

In the matter of rejections, too, the inspector must be prepared to meet any challenge emanating from the supplier. It may be that the latter is not convinced of the justice of the inspector's decision, and when this is the case the buyer should give the supplier the opportunity of personally arguing his case, should he so desire. If the inspection is efficiently carried out, however, such cases are by no means frequent, but should a supplier desire to confer with the inspector in regard to a rejected consignment, every facility to do so should be offered. The chances are that a personal visit will clear away misunderstandings, and effectively remove all causes for complaint in connection with subsequent deliveries.

The wise buyer always studies the wishes of those for whom he caters, and being in close association he can view things from the shop standpoint. He is not the autocrat who says, "I cannot help what you want—it is this you must have." Rather would he say, "I see what you require, and why you require it, and I will endeavour to meet your wishes." So when it is suggested that a certain make of files is not giving satisfaction, he tries another make, and yet another, until satisfaction is secured.

The storekeeper complains of the quality of the brushes; the electrician of the quality of the lamps; and, after all, these are the people who *should* know, and the buyer must endeavour to satisfy them. This does not mean that he need pander to their extravagance, or uphold their prejudice. If his records are in order he can guard against both. He can see how many brushes, or how many lamps, have been used during a certain period, and can compare with an earlier period. He may order a higher priced article, and after a time again make a comparison. If the change has proved successful, taking into consideration the increased cost, he is justified in continuing; but should the consumption

still be the same (under similar conditions) then he reverts to the lower priced article.

The Purchasing Department under the progress manager is not content to do that which has been done, but is constantly looking ahead. Just as improvements in the methods of manufacture are engaging the attention of the planner and the foreman, so also are improvements engaging the attention of the buyer. As new methods are brought out, the manufacturing departments become more efficient. Their output is greater, and the intake is also greater. This means that greater efforts are necessary on the part of the progress manager who must ensure adequate supplies of material being available.

Thus, the Purchasing Department must keep up to the standard of the shops, and in this connection the buyer is constantly on the "look out." Travellers arrive at the factory desiring an interview, and in practically every instance this is granted. The buyer may not be in the market at the moment for the particular commodity represented, but, nevertheless, he sees the traveller and loses nothing in consequence. He recognizes that the traveller is "in the know," and valuable information may result from a few minutes' interview. The buyer who is too busy to interview misses much, and the writer would advise the buyer to see his callers, and make a point to ensure that the time so occupied is productive. Whatever it may result in, so far as the caller is concerned, it can always be advantageous to the buyer.

The progressive buyer is always prepared to accept samples and arrange for these to be tested and reported upon. In this way the latest developments are exploited, and there is no fear of the factory falling behind. No matter if satisfaction has been attained in regard to any specific commodity, there is always the possibility of something better, and if a caller desires to submit a sample of his goods, let him do so by all means. It may prove better, in which case subsequent procedure is obvious, whilst, on the other hand, it may prove inferior to that already in use. In this latter case the buyer has the satisfaction of knowing that his judgment has not been at fault, so it will be seen that in either event the buyer does not stand to lose.

The samples are, upon receipt, passed to the inspector, accompanied by a form giving brief particulars, and the inspector reports

accordingly. In regard to raw material, he may desire certain machining operations in order to determine its capabilities, and this is arranged for by the progress manager. The latter relies entirely

INSPECTION OF SAMPLES

To Inspection Dept. Date..............................

From Purchasing Dept.

SAMPLES as under have been received

From ....

Please examine and send your Report *to the undersigned.*

Particulars

Signed.......... ....

Fig. 45

upon the inspector's report and advises the sender of the sample in accordance with this.

It will thus be seen that the engineer is intimately concerned, and that, so far from being ignored, his opinion is really the determining factor. So long as the shops and the Purchasing Department work together and appreciate each other's viewpoint, all is well.

CHAPTER XXIV

PURCHASING ROUTINE

THE Purchasing Department is responsible for all actual buying, and no other person in the factory, no matter how highly placed, is authorized to place a requisition upon an outside firm for supplies. Even the works manager, should he desire to order, must observe this rule, by passing the necessary instructions to the Purchasing Department.

Certain persons in responsible positions are privileged to requisition the Purchasing Department for supplies, but in some instances the requisitions may be challenged by the progress manager, although they must never be ignored. It is observed that the progress manager is a buyer and not a buying clerk, and his responsibilities are great. He must intelligently interpret his duties, ensuring for the factory adequate supplies, but with due regard to finance. Thus it is that he does not, as a matter of course, buy as instructed, but satisfies himself that the instruction received is perfectly legitimate. The unique position he occupies makes this possible.

A requisition from the works manager is, of course, accepted without comment, but in regard to other requisitions these are liable to be questioned. In the matter of tool steel or special tools, these are requisitioned by the tool room chief, and although they may be accepted, an eye is kept upon expenditure under this heading, a weekly or a monthly summary being submitted to the works manager for his comments.

All stocks which are kept upon a maximum and minimum basis are ordered automatically as the stock reaches the minimum figure, these including small standard tools (drills, files, taps, etc.), material for components manufactured in the factory (bar and sheet material, castings, stampings, etc.), component parts bought out finished (rubber, vulcanite, and other goods, balls, ball bearings, etc.), and stationery (standardized forms, memos, invoices, etc.), all these being ordered in accordance with the storekeeper's requisition. Although, in the main, this procedure is adhered to, the progress

manager is allowed considerable latitude, in order to take advantage of the market. For instance, he will buy heavily if the market shows a tendency to rise, whilst on a falling market he will allow stocks to fall below the minimum figure if he considers this an advantage.

As far as possible, stock details (brushes, waste, oils, greases, etc.) are maintained upon a standard basis and requisitioned accordingly, but wherever this is not possible, the storekeeper's requisition, endorsed by the progress manager, is accepted. Requisitions for special parts, signed by the head of a department, must be endorsed by the works manager before acceptance, and even then these may be challenged by the progress manager if he is convinced that abnormal quantities are being ordered.

A requisition is rarely placed upon an outside supplier until a quotation has been invited and received, the exception being in the case of proprietary articles, or where there is a definite understanding that repeat orders shall be given to one firm. The buyer has a "guide," which is kept up to date, and from the names appearing therein a selection of four or more is made for soliciting quotations for the supply of a certain class of material. The names

BUYER'S GUIDE

CASTINGS (Iron)	CASTINGS (Malleable)	CASTINGS (Non-Ferrous)
FIRM (Name & Address)	FIRM (Name & Address)	FIRM (Name & Address)

FIG. 46

of the firms appear under the heading of the specific supply, all firms handling small screws appearing under one heading, firms dealing in malleable iron castings under another, and so on. Thus,

assuming that quotations for the supply of small screws are to be invited, and a dozen firms' names appear under this heading,

PURCHASING COST CARD

Drawing No........................ Name of Part..

Name and Address of Supplier	Price				Discount			Carriage	Remarks
	Per				Trade	Cash			

(*Front*)

QUOTATIONS

Firm—		Firm—		Firm—		Firm—	
Date	Particulars	Date	Particulars	Date	Particulars	Date	Particulars
Firm—		Firm—		Firm—		Firm—	
Date	Particulars	Date	Particulars	Date	Particulars	Date	Particulars

(*Back*)

Fig. 47

at least four of these names are selected, and the inquiry sent to each.

It is necessary for the buyer to have a definite method of selection, and a record of those firms with which business has already been done must be compiled. This is a card record filed under the class of supply, each card referring to a specific article, and giving a brief record of all past dealings. For instance, one set of cards covers all malleable castings, and there being seven different components made in this metal the set comprises seven cards, one for each drawing number.

Taking one of these for the purpose of illustration, we find that the drawing number is 2620, and that the last purchase was from Jones & Co., at a certain price. We also find that Brown, Ltd., and Robinson & Son also quoted but lost the order on price, that of the first named being so high that it is not considered good policy to invite them to quote again. These being the only names upon the card, and Brown, Ltd., being out of the question, reference is made to the "guide," and the firm of Tomkins is selected. So this time the inquiry is sent to Jones, Robinson, and Tomkins, and when the quotations are received they are entered upon the card, special reference being made to the firm which secures the order.

It is not, however, the lowest quotation which gets the order, neither is price the only factor in making selections for soliciting quotations. It may be that the firm which supplied previously let down the buyer badly on delivery, or it may be that the goods supplied were of inferior quality. Both these factors are taken into consideration when quotations are about to be invited, and, whenever it is decided to drop one firm on account of price, delivery, or workmanship, another firm is brought in to take its place.

It is in this way that the best market for any specific product is found, which is, of course, the aim and object of the buyer. It does not follow, however, that because a firm fails to give satisfaction in one direction, it is incapable of giving any satisfaction at all. The firm may have facilities which enable it to compete for one type of article with every chance of success, whilst in connection with another type (although there is a broad similarity) it is hopelessly "at sea." To quote one case as an illustration, four firms were invited to quote for a specific steel washer, and the

quotations were as follows: (1) 2s. 9d.; (2) 2s. 11d.; (3) 3s.; and (4) 8s. 6d. per gross.

It was obvious that the last named was quite out of the running, the product of the cheaper firms being quite satisfactory. Yet that last mentioned firm has competed successfully for the supply of other steel washers, but of a different type, and in time the buyer knew exactly when to include this firm in his selection. When inviting quotations for goods to a blue print, a discriminating selection of firms must be made, and if the card record referred to is intelligently compiled, a proper selection will follow.

In sending out an inquiry, care must be taken to ensure this being intelligible to the recipient, so that a competitive quotation may be

INQUIRY

Date..............................

From .... To ....

....

....

We shall be pleased to receive your quotation for the supply of PARTS as under, delivered to Specification attached.

We would specifically draw your attention to the fact that goods must be absolutely in accordance with Specification, as in the event of an order being placed with you no parts can be accepted unless this condition is observed.

Please advise DELIVERY DATE, and return the Specification with your quotation.

FIG. 48

received. Many a firm has sent in a high quotation and consequently lost the order, because the inquiry has not been definitely understood, and this is unfair to the firm in question and also to the buyer, for the latter has, in all probability, lost a very good chance of obtaining a good article at a reasonable figure. Conversely, the inquiry may be interpreted as referring to a simple proposition, the firm being deluded into sending in a very low quotation which is promptly accepted by the buyer. The satisfaction of both parties, however, is but short lived, for one of two things will happen.

Either the supplier will discover his error when commencing manufacture (or upon receipt of the detailed specification) and endeavour to impose a higher figure (this, obviously, being resented by the buyer), or the supplier, in order to meet the quotation, will send in goods of an inferior quality, or minus certain essentials, which are indignantly rejected.

This does not conduce to amicable business relations. Voluminous correspondence, involving a waste of time, energy and temper, and delay consequent upon the non-receipt of the article under discussion, will convince the buyer that he has made a bad move. Sharp practice on the part of either the buyer or the seller does not pay. It may be successful once, but in the end the guilty one gets his true deserts, and it is up to the buyer, at all events (as one who must consider the future as well as the present), to insist upon fair dealing, this being the only method by which he may hope to get the best results.

The inquiry, then, must be intelligently worded, and should be accompanied by the complete specification, which is usually in the form of a blue print. The specification should be definite, and any special point clearly shown. If this is quite in order, and the inquiry states that the goods will not be accepted unless they conform to the specification in every particular, the prospective supplier can gauge the measure of his commitments and quote accordingly. Should the quotation materialize into an order, the onus is upon the supplier to deliver the goods strictly in accordance with the specification. Should he do so, the buyer must accept, even though inspection reveals that the goods are unusable through an error on the specification.

The buyer must insist upon blue prints being returned with the quotation. There is a tendency on the part of some firms to send in a quotation but to retain the blue print, on the off-chance of the quotation proving successful. There is, in some instances, a deeper reason than this, it being feared that, after the quotation has been sent, certain additions (involving heavier cost) will be made to the specification, and an order placed upon the original terms. Such a thought, however, could only exist in the minds of those who have some reason to distrust the buyer, and once again the value of fair dealing is emphasized.

The inquiry should state that, unless specifications are returned,

no order will follow; and should the prospective supplier, despite this warning, still omit to return the specification, he should be specifically asked for it, and no order should be given to a firm unless this request is complied with. Insistence in this direction is really necessary, for it may be that the firm has an old specification to which goods covered by a later order are made. As the existing specification is somewhat different from its predecessor, the goods are incorrect, and trouble is occasioned by the firm producing the obsolete specification as the official instruction.

When the quotations have been compared, and one selected for acceptance, an official order is sent to the firm concerned, together with the blue print or specification. This should state the particulars of the order, reference being made to the "blue print attached," and also "in accordance with your quotation of the —th." It should be observed that in sending out an inquiry a delivery estimate should be required, and this must appear on the quotation. Too often this important factor is omitted until the official order is made out, when "delivery required in one month" will be specified. As the firm has given no promise of delivery, the delivery date upon the order cannot very well be insisted upon. The firm may make every endeavour to meet the date, but it is not liable if it does not succeed, the fact that it has accepted an order bearing a delivery date not being evidence.

The official requisition, as before mentioned, is made out in triplicate, the first copy going to the supplier, the second retained in the Purchasing Department, and the third copy used for a variety of purposes, some of which have already been enumerated. Each requisition is numbered, these numbers running consecutively, and it is by this means that any subsequent reference is made to the order, the second copy being filed for this purpose. Prior to the filing of the second copy, a record of the goods ordered is made upon the Purchasing Card, which is filed under the name of the supplier, or under the drawing number of the article ordered. If the first method be favoured, all goods, no matter what they may be, are recorded on the card bearing the name of the firm supplying, whilst in the other case all orders in connection with a specific drawing number are recorded upon the card bearing that number, even though they be upon three or four different firms. It is sometimes considered desirable to have both sets of card records,

and when this is the case reference is made much easier, by quoting the requisition number, the name of supplier, or the drawing number of the article concerned.

The third copy of the requisition is, in the first instance, sent to the person primarily responsible for the order; that is to say, all orders emanating from the store are sent to the storekeeper, and orders covering special details to the individual concerned. This

PURCHASING RECORD CARD

Supplier's Name..

Date	Requisition No.	Quan.	Name of Part	Delivery Due	Urged	Prom.	Recd.

FIG. 49

enables the interested parties to make what records are necessary for their own use, whilst it brings to light any error which may have been made. The person interested signs the third copy, which is returned to the Purchasing Department, where it is filed pending an advice of dispatch.

The question of "speeding up" delivery must next engage the attention of the buyer, this being done upon his own initiative apart from the prompting he receives from interested parties. Indeed, should an urgent message be received from any department relating to goods on order, the buyer should be able to reply immediately, giving definite information. It should not be that the prompting of another department causes the buyer to move in the first instance, for that is the cause of a good deal of delay.

A delivery date having been agreed to in connection with every order, the buyer does all possible to ensure this being kept, and assuming that no intimation has been received that the date cannot be kept, he sends a reminder to the supplier a short time before the

From .... To ....

....

....

Reference No...................... Date...........................

REMINDER

Our Order................................. Covering...

Due for Delivery ....has not been completed.

Your Special Attention and a Reply per return will oblige.

FIG. 50

date due. Should the supplier reply stating that the date cannot be kept, but offering a revised date, the buyer must consider how this will affect his commitments, and advise the interested department accordingly.

As the progress manager controls the Purchasing Department he can readily determine what the effect will be upon the shops, and he takes immediate steps to obviate (or at least minimize) any trouble arising. He may consider it necessary to place a smaller order elsewhere at a higher figure, but with the certainty of speedy delivery; or he may decide to visit the supplier with a view to emphasizing the urgency of the order. The progress manager cannot excuse himself on the score of his inability to obtain outside supplies. He is the buyer, and the remedy is in his own hands.

All revisions and promises are recorded upon the purchasing card, and any inquiry can therefore be answered promptly. The system should allow for every outstanding order coming under review at stated periods, and it should be impossible for any order to be overlooked. Information accorded should be definite—the buyer

should never say, in response to an inquiry, "I have no definite promise but will write the supplier and advise you later."

When an advice note is received, intimating that goods have been dispatched, the fact is recorded upon the card, and the advice note and the third copy of the requisition then sent to the Receiving Store. Every day a "Goods Received List" is received in the Purchasing Department, and this is used for the purpose of posting the purchasing cards. The invoice arrives in due course and is checked by the records made, but this is not passed for payment until the inspector's report has been received.

The inspector's report (attached to the third copy of the requisition) having come to hand, deductions are made upon the purchasing card to correspond with the number of parts rejected, and the supplier is notified. In due course the rejected goods are returned to the supplier, and the invoice is held pending receipt of a credit note for the goods returned. When this comes to hand, the necessary records are made and the invoice passed for payment. If the rejected goods are to be replaced, the requisition is kept open until these are received and passed by the inspector.

The "Packing Account" must be closely watched by the buyer, otherwise heavy expense will be incurred for comparatively unimportant items. A record is kept of all packages which are returnable and upon which charges are made, and these are returned to the sender with the least possible delay. The record should be scrutinized very closely, and a dispatch note for the return of any outstanding package sent to the Receiving Store. Care must be taken to ensure these being correctly consigned, otherwise there is trouble with the railway company, or a lot of unnecessary expense incurred. After the package has been sent off, the dispatch note is returned to the Purchasing Department, and the supplier is notified and a credit note obtained.

CHAPTER XXV

THE STORES CONTROLLER

STOREKEEPING in the engineering factory has become a science, and the lot of the storekeeper to-day is full of promise, seeing that his duties are becoming more and more important as the question of scientific management develops. For in the modern factory his claims cannot be disregarded. No scheme or development is complete without his inclusion, for his department is the very centre of the factory administration.

The old-fashioned ideas regarding the store have been swept into oblivion, and it may be said that no department in the factory has been more completely revolutionized. New departments have sprung into existence, but these perforce were equipped with modern ideas at the very start, whereas the store, the oldest established department, has had to change its course to fit in with the new scheme of things consequent upon modern organization.

The store must be as efficient as the most modern department in the factory, and the storekeeper must rank amongst the experts. He must know as much about his job as the works manager does about his, for, like every other department, the store must be positive. It is an integral part of the organization and is as much concerned with production as is the machining department.

In the main, the storekeepers of the old days, when the store was but lightly regarded, might have been divided into two classes and their methods, accomplishments and achievements may for a moment be considered. One of each type may be selected for the purposes of illustration, which will clearly show that neither is fitted to preside over the destinies of the present day store.

X, the stores controller in a large factory, was a pompous individual who knew rather less about storekeeping than does the average office boy. His appointment was obviously the result of influence in high places, for his qualifications were nil. He was in receipt of a nice salary, and was on intimate terms with the other high officials, in whose company he would spend the major portion of his time. The store, as has been suggested, did not count for

much in the eyes of the management, and what work was necessary was deputed to the minor officials. The controller, when he condescended to recognize that he was in charge of a department, would make a tour of inspection, discharge one of the boys for skylarking, reprimand one or two hard-working officials upon some frivolous pretext, and retire to his office.

Such a man could never be a success—neither did he desire to be. He had no energy—no ambition. He had a comfortable billet and he was quite content. As may be expected, such miscontrol was responsible for much dissatisfaction on the part of the underlings, who very often had to work much harder than the results would warrant. He could not organize—could not control—and so things went on until the management awoke to the fact that, in order to get adequate results from the factory, the store must do its part. Then it is that influence must give place to efficiency. A fund is raised; a handsome testimonial presented to the accompaniment of many pretty speeches—and for the store, under real control, a new era dawns.

Now for an example of the second type of old time storekeeper. Z was a very industrious fellow, well versed in detail but quite incapable of control. His status was very little above that of the ordinary labourer, and his wage rate was surprisingly small. He was too insignificant to be on friendly terms with the heads of other departments, and was, in fact, the "maid of all work," submitting to the instructions of all and sundry. His department was the scapegoat of the factory, for the heads of other departments did not scruple to cover up their own delinquencies at the expense of an unorganized and inefficient store.

The man in charge was the only one in the store who really worked, for his subordinates were of the "fetch and carry" variety, doing what they were told, and no more. To a storekeeper of this type, working under the conditions described, it was usually the simpler proposition to do the work himself than to depute others to do it, and as there was obviously a limit even to his capacity, efficiency in the store even to a minor degree was lacking.

Here, again, the sad state of affairs continued until the management of the factory was sufficiently educated to perceive what was wrong, and then the store was placed under proper control. A practical storekeeper was placed in charge, and a minor post in

the store, for which he was eminently suited, given to the individual who had so gallantly striven to do justice to a position really too big for him. His duties were lighter, yet he accomplished more, and he was satisfied.

So much for the "old type" storekeeper, and now for the modern product. The latter differs considerably from the accepted type of some years ago, and yet it must not be inferred that he is a new-comer to the business. As a matter of fact, he was in the factory years ago, and gained his experience under the man we have styled the "old timer." He may have been fortunate in his chief, for there *were* storekeepers then—men who knew their business and how to handle a store, but who, on account of the very slow growth of factory organization, did not have the opportunities available to the present day man. This individual is with us to-day, and is an efficient storekeeper judged by a present day standard, for he would not allow himself to get into the rut even when matters were at their worst.

Although the store forms part of the progress organization and is, as a consequence, under the supreme control of the progress manager, the man in charge of the store must be a man of considerable experience and an expert organizer. Like every other foreman, he is expected to get the best out of his department, and for him to accomplish this he must possess the characteristics which denote leadership. He is no figure-head—he is the active director of affairs. He is not immersed in detail, but he knows enough of detail to understand thoroughly what is going on. His department must at least be as efficient as any other department in the factory, or, to be more precise, it must be up to the standard of the most efficient department.

The development of scientific management in the productive departments brought about the revolution in the store, for in the first instance the latter department was ignored by the experts, and it was not until they saw that the efficient co-operation of the store was essential to the success of the scheme that interest in the store was excited.

For the store a duplex system of control is advocated, for the brilliant organizer is rarely the absolute master of detail. The plan upon which he works does not permit an exhaustive study of detail, neither should this be really necessary, seeing that his business

is to get the best out of his subordinates rather than to do the job himself. If he applies himself to detail, he can do so much and no more than another, and whilst engrossed in detail obviously he cannot control. But if, on the other hand, the chief storekeeper is a first class organizer, capable of managing the department, and at the same time possessing such knowledge of detail as to enable him to give a decision promptly, and also sufficient to keep him in touch with the day to day working of the department, whilst his chief assistant is an expert detail man, the combination cannot fail to be successful.

The scope of the chief storekeeper may be said to extend over the central works stores, although his activities vary in accordance with the general system prevailing in the factory. In the small factory where the volume of work is not great he may handle, not only the stocked component parts and the raw supplies, with all the records appertaining thereto, but also the parts which are supposed to be in progress but temporarily lodged in the store for convenience. In the latter instance a part of the store is set apart for the accommodation of such parts, these being issued upon receipt of an operation card or upon a foreman's requisition. In the larger factory all work in progress, no matter where it may be, is handled by the progress man, and if temporarily lodged in a store or in a department pool, such store or pool is directly controlled by the Progress Department.

The chief storekeeper is the "Minister of Supply," and he must see that adequate stocks are always available. He must develop the resources of his department in order to obviate "waiting time," and everything must be handled promptly, whether at the counter or in the office. The "lay-out" of the store must be simple yet effective, and there should be no question of anything being "lost" or "mislaid." No goods must be issued without authority, and goods once issued must not be exchanged unless they have passed through the Inspection Department and are certified correct. In fact no goods, in any circumstances, must be received into store unless accompanied by an inspector's report, and the storekeeper has the right to assume that he holds no defective article.

CHAPTER XXVI

THE WORKS STORE

It is proposed to devote this chapter entirely to a definite system of stores organization suitable for a large factory, and it may be said at once that a system similar to the one about to be described is in actual operation, and has proved in every way satisfactory and efficient.

In the large factory the store organization must perforce be of an elaborate character, on account of the vast field of operation, but this does not mean that it need be cumbrous, if properly worked. It must be comprehensive, but there need be no overlapping, for intelligent sectionizing will ensure an equitable division of duties, so that each person knows exactly what he has to do—where his activities start, and where they end.

The idea is for a main central store as a source of supply for the whole factory, this being divided into definite departments, and each department again sub-divided into sections. To facilitate progress and to simplify procedure, a sub-store is situate in each of the manufacturing departments, these sub-stores receiving supplies from the central store, and issuing them to the manufacturing department being catered for.

The organization of the central store is upon the duplex principle —that is to say, the clerical work, and the actual handling of stores are identified the one with the other. Each store department has its own clerical staff, and that staff is sectionized in precisely the same manner as is the handling side. To make this clearly understood, we will assume that the system is operating in a factory engaged upon the manufacture of electrical appliances.

The following classes of apparatus are under manufacture: (1) Controllers; (2) Switchgears; (3) D.C. Motors; (4) A.C. Motors; and (5) Generators; and for each of these lines there is a separate manufacturing department. It follows, therefore, that to ensure efficiency there are at the moment five definite departments comprising the store organization.

These are, however, supplemented by further departments, for in certain instances it is not possible for these five store departments to handle the whole of the work required in connection with

the manufactures named. Two examples may be cited to illustrate this, the first dealing with the storage and supply of bar and sheet material, etc. This material is not entirely identified with any one specific line of manufacture, for it is just as likely for the A.C. Motor Department to require $\frac{5}{8}$ in. diameter mild steel bar as for the Generator Department. As such material is for general use, it cannot well be divided and stored in each of the five store departments already referred to, and so a separate store department

THE WORKS STORE

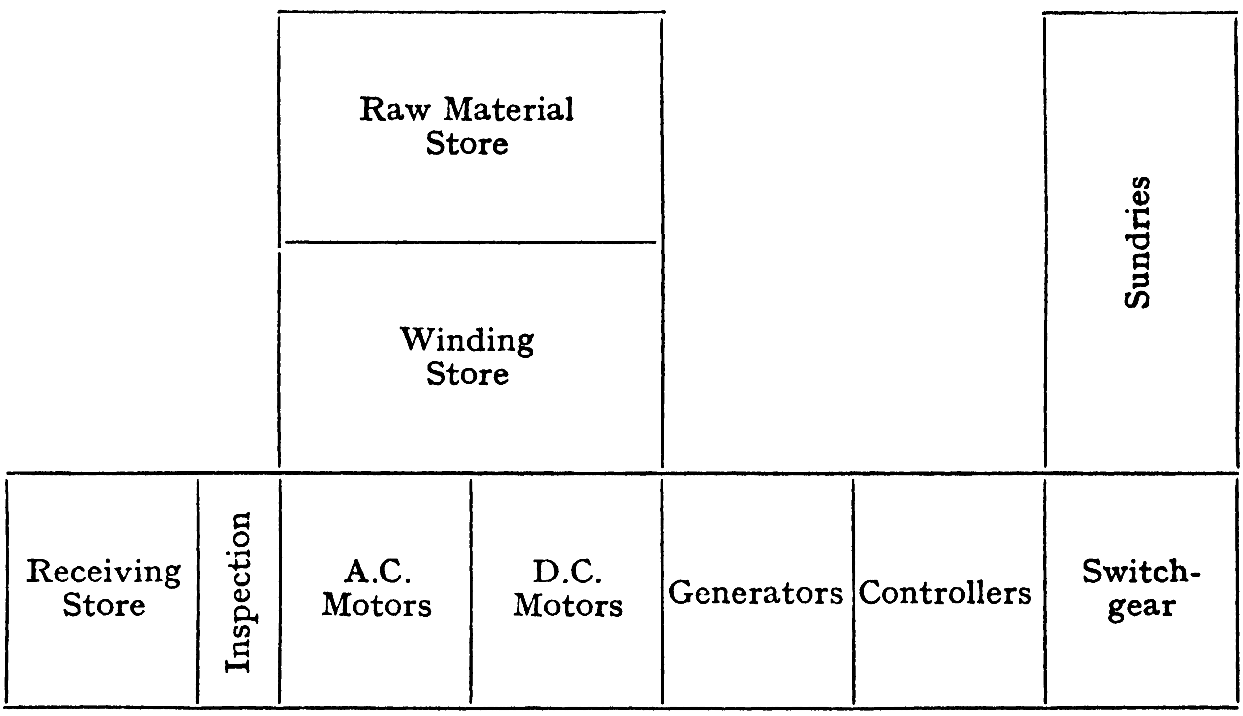


FIG. 51

is necessary to cater for the needs of the whole factory in this connection.

The second illustration is in reference to winding, although the actual application is different from the foregoing. There is in the factory, as already stated, an A.C. Motor Manufacturing Department, a Generator Department, etc., and although the inference is that the product is entirely manufactured in the department to which it has given its name, this is not so in regard to castings, forgings, and windings, which are handled by specialized departments catering for the whole factory. Thus, to supply the needs of the Winding Department, there is an associate store department, this bringing the number of definite store departments to seven.

It will perhaps be well, before proceeding farther, to consider the functions of these seven departments, which together with the Receiving Department (which is dealt with elsewhere) may be said to constitute the "Works Stores."

It has already been said that the stores departments are subdivided into sections, which in the main comprise "Receiving" and "Issuing," and it is obvious that in the interests of efficiency these must not be allowed to clash. The one is as important as the other, for without receipts there can be no issues, whilst without issues receipts are unnecessary. As each of the five store departments associated with definite classes of manufacture is worked on a common system, one of these may be taken to illustrate the mode of procedure.

The A.C. Motor Store caters specifically for the department manufacturing that product, and therefore confines itself to the parts required in connection with the same. This store department has its own clerical staff, and activity in connection with any order commences with the arrival of the specification list.

This list is received from the specification section attached to the Drawing Office, either direct or via the Progress Office—and enumerated upon it is every detail required in connection with the unit on order. The order may cover anything from one to one hundred A.C. motors, but, whatever the number, they must be absolutely identical as regards size, type, etc. If but one motor is on order, then the details shown are sufficient for one motor, but if, say, the order covers twenty motors, then the quantities of the details are multiplied accordingly.

The specification list gives the route order of every item, so that it is easy for the store department to determine which of the items it is called upon to handle. To condense the routeing, each department is given a figure or a letter, and assuming that the store is known as Figure 1, and the manufacturing department for A.C. motors Figure 5, it is obvious that all items so routed (with the exception of bar and sheet material) are to be dealt with by the associated store department.

It has been said that the duplex principle is favoured, by which is meant that the clerical work and the actual handling are dealt with simultaneously. Two copies of the specification list are therefore necessary for the store department, but experience proves

that the additional expense incurred by this is more than covered by the efficiency attained. The following will serve to illustrate what is meant.

In a certain factory it once was the practice to issue one copy of each specification list to the store department, and this, in the first instance, went to the clerical side for recording purposes. The class of manufacture was on a rapid delivery basis, the store being allowed but two days in which to issue certain details to the manufacturing department. Considering that sometimes a dozen different lists were received during one day, and that about one hundred items were covered by each, this necessitating posting

COMPONENT STOCK RECORD CARD

Drawing No.................... Name of Part.................................... | Max. ....
Made from.................................... Used on................................ | Min. ....
Speed Ups, | Pattern............
etc. | Templet ....

Date	IN		OUT			Stock	Date	IN		OUT			Stock
	Quan.	On Order	Quan.	Order No.	Date Sup-plied			Quan.	On Order	Quan.	Order No.	Date Sup-plied	

FIG. 52

one hundred different stock cards, it is obvious that delays in issuing would be frequent, as the store man did not get the list until the whole of the items had been posted.

These delays suggested a change of procedure, and the duplex principle was adopted. The clerk received his copy of the specification list as heretofore, but at the same time a further copy was sent to the man in charge of the issuing section. This individual was thus enabled to commence operations forthwith without waiting for the clerical records to be compiled, the clerical work and issuing being taken in hand at one and the same time, thus obviating delay.

Now it is a well-known fact that, no matter what precautions are taken, it is almost impossible to ensure the recorded and actual stocks being absolutely identical. A good deal of time has been spent in attempting to evolve the perfect record, but human agency being what it is, success is not yet absolute. The duplex system under review has, however, helped considerably, for it promptly brings to light discrepancies which otherwise might remain hidden for some time longer.

Upon receipt of the specification list the clerk immediately posts the details upon the stock record card. The usual procedure is for each component part to be recorded on its own stock card as shown in the illustration, this card being designed to show (1) the number of receipts; (2) the number of issues together with the order number; and (3) the number of parts still available after all orders are cleared. Assuming that one assembly is comprised of one hundred different components, this means that one hundred stock record cards must be handled each time an order is received covering that specific assembly.

The fact that, owing to the application of the duplex principle, the section man need not await the instructions of the clerk, suggests that the latter can do his work in a systematic manner by posting several orders at one and same time, this reducing the number of card handlings. Under the old method, which allowed but one copy of each specification list, the clerk was obliged to post an order immediately the list was received so as to pass it on to the section man with as little delay as possible. After handling one hundred cards he would probably find another list (covering a similar assembly) awaiting him, and once again that same one hundred cards would have to be handled.

The present method is for the clerk to do his posting periodically, care being taken to see that all orders are cleared on the day they are received. Each list is stamped with the time and date received, and assuming that by a given time some three or four identical lists are received, these are posted simultaneously, so that the one hundred cards are handled but once instead of three or four times as under the old method.

With standard parts, the practice is to work upon a maximum and minimum basis, both sets of figures being set forth on the stock record card. The minimum figure is, as a rule, regarded

as the ordering point and not as the lowest quantity to be held in stock, and immediately this figure is reached the clerk places a requisition for further supplies. The ordering point is based upon the estimated requirements for a given period, this period varying in accordance with the time necessary to get the new supplies into stock. In some cases a six weeks' supply is considered ample, whilst in others a twelve weeks' supply is necessary. The maximum figure is usually fixed in relation to the minimum, although even here there are variations, consequent upon (1) the time required to get the parts into stock, and (2) the economical manufacturing quantity. The maximum figure may therefore be (*a*) twice the minimum, (*b*) three times the minimum, and (*c*) in exceptional cases still higher.

REQUISITION FOR STOCK ORDER

STOCK ORDER Number ....

TO PROGRESS OFFICE Date.......................................

Please put in hand the following work for STOCK—

Required by... Signed...
Storekeeper.

Please return this order to Works Stores when completed.

FIG. 53

Everything, of course, depends upon the demand, so for illustrative purposes we will assume that the output is forty units per week. For the component of which but one is required for each unit, the order point (on a three months' demand) would be 520, and the maximum figure, at three times the minimum, 1560. The requisition for new supplies placed when the minimum figure is reached would probably cover 1500 pieces.

It is here that the stock clerk must use discretion, for, in certain cases, on account of the lengthy time involved in operation, it would be policy to order but a small number, whilst in others the

order should cover a larger quantity. If the part is produced upon an automatic lathe or upon a press, a comparatively small quantity would be an uneconomical proposition, and so, in such circumstances, the maximum quantity must be quite disproportionate to the minimum.

The stock clerk must know where to order; that is to say, whether the part is manufactured in the factory, or purchased from outside. If the part is to be made in the factory there is no need for the clerk to know in which department the order will be placed, as this is dealt with either by the Planning or by the Progress Department.

OUTSIDE PURCHASE REQUISITION

TO PURCHASING DEPARTMENT No....................

FROM WORKS STORES Date..................................

Please order the following for Stock. Required by...................

Quantity	Drawing or Specification	Particulars	Comments

Signed... Signed...
Stock Clerk. *Chief Storekeeper.*

FIG. 54

The business of the stock clerk is not finished with the placing of the order, for he must acquaint the Progress Department with the urgency of the order with a view to maintaining adequate stocks.

Each item on the specification list is cancelled by the stock clerk as the record is made on the card, but if, through shortage of stock, any specific item cannot be posted, the cancellation is left until the stocks are repleted and the card record cleared. The list is then sent to the clerk in the next section having any interest in the order, i.e. the bar material, or the winding. These are dealt with later.

We may now trace the working of the other copy of the specification list, which has been sent direct to the section leader, and which

is used in connection with the actual handling of material. This list is the storeman's authority to assemble and then issue the parts to the manufacturing department concerned, no foreman's requisition or demand note being necessary. It is known that in connection with this line of manufacture speedy delivery is essential, and so, without loss to time, the necessary parts as enumerated on the list are sent to the interested department.

Each item on the specification list is cancelled as the parts are assembled, in precisely the same way as the other copy is treated by the clerk when posting. The stores lockers, or bins, are arranged so that each contains a quantity of a given component; that is to say, just as one stock record card is used in connection with each

"IN AND OUT" STOCK RECORD

Drawing No.................... Name of Part.................................. Bin. No................

IN				OUT			
Date	Order No.	Quantity	Total	Date	Order No.	Quantity	Total

FIG. 55

specific component, so also is one locker set apart for the actual storage of that component. In each locker will be found what is termed an "In and Out" stock card, this recording all issues and receipts.

In the event of the store being unable to clear the specification list (so far as that section is concerned) the storeman immediately reports to the clerk, and thus any variation between the recorded and the actual stock is brought to light. The stock record card is checked against the "In and Out" card, and the necessary adjustments made. The specification list, when cleared as far as

possible, is, like its fellow on the clerical side, sent to the next section.

Assuming that the next section is the bar material store, we may again deal with the clerical side first. This department, like the preceding one, has its own clerk, but attention is drawn to the fact that this department is concerned, not merely with one specific line of manufacture, but with every order in connection with which bar material is required. Thus, here, a greater number of specification lists will be handled, but as only a comparatively few items on each require posting, the work is not so heavy as at first appears.

The clerk in this department has a set of stock record cards, but instead of each card dealing with a specific component, as in the preceding department, it deals with one certain size of bar. Thus, one card records the movements of ½ in. diameter bright drawn

RAW MATERIAL RECORD CARD

Ordered				Received			Issued			
Date	Reqn.	Supplier	Weight (lb.)	Date	Quan.	Outst'g.	Order	Weight	Stock	Date

Fig. 56

steel, another ⅞ in. hexagon steel bar, and so on. The specification list may read as follows—"Item 10—20 rotor shafts to drawing 5,620. Material required—44 ft. of 1¼ in. diameter bright drawn steel," and the item is posted upon the card recording the movements of that size of steel.

The stocks here are maintained upon a maximum and minimum basis as in the case of components, and immediately the ordering point is reached the clerk places a requisition upon the Purchasing Department for further supplies. It must be observed here that in many instances recorded stocks are not actual stocks so far as general utility goes, for it must be borne in mind that for certain

operations, such as automatic or capstan bar work, short pieces of material are useless. The card record may show 100 ft. of stock, and receiving an order for 96 ft., the clerk imagines he can just clear the order, only to find that 20 ft. of the material is in short lengths, and therefore not suitable for that particular work.

Much depends upon the actual handling, and the section leader must interpret his orders intelligently so as to use his material to the best advantage. He must know the operation for which the material is required and, wherever possible, issue the short ends first. Sometimes the bar is too long for economical handling, and the manufacturing foreman desires the storeman to cut the bar in half before issuing. In doing this the possibility of getting short ends is increased, and the storeman, before acceding to such a request, should ascertain the length of the articles to be manufactured, and cut his bar in accordance. Much scrap can be obviated if this precaution is taken, and the card records are, as a consequence, more reliable.

The bar material section man accepts the specification list as his authority for providing the material, and when cleared, so far as this department is concerned, the list is sent to the winding section.

As this section deals with the winding requirements of all orders, even though but one manufacturing department is in the main concerned, the card records again vary. The stock of wire is shown by weight, there being one card for each gauge or classification, and the specification list specifies the classification and the weight of wire required. Records are also kept relating to flux, solder, insulating tapes, and other incidentals, although here a certain latitude must be allowed. Instead of a definite quantity of solder, etc., being recorded against each specification list, the shop foreman requisitions such supplies in bulk, these being charged against the department and records made accordingly. In regard to terminals, couplings, etc., these are given a definite drawing number, and the movements are recorded in a manner similar to those of other components.

In issuing wire to the shop, the exact amount given upon the specification list is not sent, for it must be borne in mind that the wire is wound over a drum, and any attempt to issue the prescribed amount would result in making a deal of scrap. To guard against this, therefore, the whole drum of wire is sent to the shop (this being

weighed before issue), the full weight being recorded against the shop. The requisite amount being used the balance is returned to the store, the shop receiving a credit note for the weight of wire returned.

Obviously it is the responsibility of the Stores Department to ensure return of any unavoidable excess issue. An Excess Material Notification Card is sent to the foreman concerned. This is made out in duplicate and a copy is filed beside the "In and Out" stock card so that a recurring review of the whereabouts of this material is maintained. By this means the Stores staff is enabled to push for return when advisable.

The specification list should by now be cleared; but assuming that one or more items are still outstanding, the list is returned to the section interested. When every item has eventually been cancelled, the clerk's copy is sent to the Costing Department, and the section leader's copy filed for reference in the General Store Office.

EXCESS MATERIAL NOTIFICATION

FROM WORKS STORES. Date................................

To DEPT. Order No...................

Excess Material has been supplied as under—

Please return as soon as possible.

Signed...

(Perforated)

....

To WORKS STORES. Date..............................

FROM DEPT. Order No...................

Excess Material has been returned as under.

Signed...

FIG. 57

It will be observed that by this method the specification list is cleared systematically, and that it cannot leave the store until every item thereon is cancelled. It will be seen also that the issues

of the manufacturing departments are made in the correct sequence, due regard being paid to the commitments of each department. Thus, in the first instance, the list is received in the stores section catering for the department responsible for the first assembly, which, perhaps, must be completed within three days from the receipt of the order. It then goes to the material section, as the raw material is wanted in the manufacturing department as early as possible. The Winding Department cannot commence operations until the assembled core is received, and so a few days longer may be allowed for the issue of the winding accessories. It may, in certain instances, be necessary to vary the sequence of issues, this being done in accordance with the special circumstances attending the order.

The receiving of standard parts into store may now be considered, and in this connection it is observed that all parts are received from (*a*) outside suppliers, and (*b*) the factory departments. Dealing with the goods in the first category, these are accepted into the factory by the Stores Receiving Department, and, after inspection,

COMPLETED PARTS TO STORES

No..................

To Works Stores. From............................Dept. Date.................................

Order No.	Drawing or Assembly No.	Quantity	Description	Inspected by

Sent by.. Received by......................................
Foreman. *Storekeeper.*

Fig. 58

distributed amongst the stores sections interested. Thus, A.C. motor details go to the A.C. section, generator details to the generator section, and so on. All bar and sheet materials are passed to

the raw material section, and wire and winding accessories to the winding section.

These goods are received by the respective section leaders, and when counted and checked, are entered upon the "In and Out" card, and put into stock. All goods are accompanied by a delivery note, which is in duplicate. Both copies are signed by the section man receiving the goods, and then one copy is returned to the sender, and the other sent to the stores section clerk. Upon receipt of the delivery note the clerk enters the contents upon his stock record card, this automatically cancelling his entry in the "goods on order" column, and the delivery note is then filed.

The same procedure is followed in connection with parts received from the factory departments, except that these are received direct from the shops and not through the Stores Receiving Department. A copy of each delivery note, whether emanating from the factory departments or from the Stores Receiving Department, is sent to the Cost Office when the goods have been accepted by the store.

One more point may be mentioned in connection with stores issues and receipts, and this refers to what are known as sub-assemblies. In a semi-standard or standard line of manufacture it is usual for a number of component parts to be assembled together, and then held in store to meet the requirements of specific orders. As an illustration the case of a motor end-shield may be quoted. The end-shield itself is one component, and as such is received in the store. It is considered advisable, however, to stock a complete end-shield, and this means the withdrawal of the component from stock and an assembled end-shield returned, i.e. fitted with bearing, lubricating pipe, and other appurtenances.

The method of dealing with sub-assemblies is on the same lines as the method of dealing with components, the placing of orders for building up these assemblies being done by the stores clerk. The component parts are recorded upon the stock cards, the end-shield, bearing, etc., each appearing upon a separate card, whilst there is also another card covering the complete sub-assembly. When an item on a specification list covers an end-shield, this implies the complete assembly and not the component, and so the posting is done on the assembly card.

When the ordering point is reached an assembling sheet is sent to the section leader, this covering a definite quantity. This is

treated as an order, and a copy sent to the Progress Office ensures instructions being issued to the Assembling Department concerned. In this case, the parts are held in stock until a requisition is received from the Manufacturing Department, when they are sent to the department concerned. The assembling sheet is then passed to the store clerk, and from him to the Cost Office. When the assembly is completed, it is received into store in the usual manner.

CHAPTER XXVII

RECEIVING, MANUFACTURING AND COMMERCIAL STORES

The previous chapter dealt with those departments which comprise what may be termed the Works Stores, with the exception of the Receiving Store. The procedure governing this being somewhat different from the foregoing, this chapter will deal first with a system suitable for the Receiving Store, and then deal with the Manufacturing Department Sub-stores and the Commercial Stores.

The Receiving Store is (as the name implies) the department which receives all goods consigned to the factory, and its importance is therefore considerable. It is good policy to have one department exclusively responsible for receiving, and if a proper scheme is formulated, and adhered to, the receiving and distribution of outside supplies is carried out expeditiously and with advantage to all concerned. It may be observed that, in the large factory at all events, trouble and delay are occasioned by wrongful distribution, and the Receiving Store must therefore be in possession of all information relating to destination. Certainty, and not assumption, must be the keynote of the department.

When it is said that all goods from outside are received first in this department it means that there must be no exceptions, and to ensure this rule being rigidly observed it is essential that the store be situated so that nothing can come into the factory unobserved. In the case of rail and heavy road transport, no trouble is as a rule occasioned, but in connection with light parcels, as delivered by carrier or by parcels post, there is danger of these sometimes slipping past. To obviate this it should be understood that no one, other than the Receiving storekeeper, is authorized to receive any parcel, this applying to heads of departments as well as to minor officials. Even in the case of stationery, delivered by the supplier's messenger, the same rule must be observed, whilst in regard to small samples which reach the Buying Office by letter post, these should be promptly sent to the Receiving Store, or proper notification of receipt tendered.

Whenever possible, the Receiving Store should receive advice

of all goods expected, and as the majority of suppliers forward an advice note through the post when the goods are dispatched, this is a simple proposition. It is in connection with the receipt of goods which have not been advised that trouble may ensue, and to obviate this the storekeeper sends to the Buying Office particulars of goods as received, on a form known as the "Goods Received Without Advice Note."

GOODS RECEIVED WITHOUT ADVICE NOTE

To Purchasing Dept. Date..............................

The following goods have been received from..............................

..............................per ....

Package	Marked	Contents		
		Quantity	Description	Weight

Signed..............................

Fig. 59

Reference has already been made to the third copy of the Purchasing Department requisition, which is held in that department pending the arrival of the advice note, when it is sent, together with the advice note, to the Receiving Store. This gives the storekeeper all the necessary information regarding quantity on order, destination, etc., and, the goods having come to hand and been checked, these, together with the third copy, are passed over to the inspector.

It is understood that all goods are inspected before leaving the Receiving Store, the reverse side of the "third copy" being used by the inspector for summarized reports. When the inspection is completed, the "third copy" is returned to the Purchasing Department.

Every batch of goods must be labelled when passed by the inspector, which means that nothing can leave the Receiving Store unless a label or tally is affixed, this being done by the inspector and not by the storekeeper. The inspector's signature appears

on each label, and the goods are then forwarded to their destination with all possible dispatch. In the case of rejected goods these are held in the store pending instructions from the Purchasing Department.

It is obvious that all goods received cannot receive immediate attention at the hands of the inspector, and so it becomes necessary

GOODS RECEIVED FROM OUTSIDE

On..............................the....................day of....................................19........

Package	Marked	From	Address	Contents	Per	Carriage Paid or Forwarded

FIG. 60

for the clerk in the Receiving Store to issue each day a "Goods Received List." This is made out in triplicate, one copy going to the Purchasing Department, the second to the Progress Office, and the third being retained in the Store. This list is made up as the goods are received, and sent to the interested departments as early as possible the following morning. It is an important document, for it enables the purchasing clerks to post their records, and gives the progress man prompt information of the receipt of goods in which he is interested, this enabling him to press the inspector for such parts as are of more than usual urgency. The return of the "third copy" of the purchasing requisition, to which is attached the inspector's report, is confirmation of the information derived from the daily "Goods Received List," and enables the passing of the invoice for payment.

The receiving storekeeper is responsible for the return of all empties to the supplier in connection with which charges are made, and he is also responsible for the return of rejected goods, he acting in accordance with instructions issued by the Purchasing Department.

This may be said to complete the actual works store organization, but there are other stores departments, notably those associated with the manufacturing departments, which must be considered.

Each of the manufacturing departments has its own store, this being under the control of the department progress man. All parts received into the department, no matter from what source, must, in the first instance, be passed into this store, these including (*a*) the standard finished component parts required for assembling purposes; (*b*) raw material for the manufacture of special parts;

RECEIVED FROM STORES

No.....................

Department.. Date.................................

Order No...................... Sheet No..................... For Unit......................................

Quantity.	Drawing No.	Name of Part.	Received
		All parts except Items 12, 23.	

FIG. 61

(*c*) special parts (either rough or finished) received from outside suppliers and required for machining or assembling. The latter are received direct from the Receiving Store, whilst the other items are received from the stores departments responsible for the specific classes of material.

No goods are received in the departmental store unless accompanied by a delivery note, and this is not signed until the quantities enumerated thereon have been checked. The sub-storekeeper has a copy of the specification list, and each item is posted as the goods are received. It is sometimes a lengthy business for all parts

to be given in detail upon the delivery note, and time may be saved if the delivery note, bearing the order number and the date, is simply endorsed—"All parts in accordance with specification list," or "All parts except Items——," or "Items 1 to 20, 35 to 50," whichever would meet the case. This means that the sub-storekeeper would check the goods to the specification list, instead of to the delivery note, but it would be practicable only in the event of the major number of items being cleared.

The sub-storekeeper not only receives goods from the main stores but also receives finished special parts, both from his own and from other manufacturing departments, such receipts being duly recorded upon the specification list. In this connection it will be observed that two receipts may appear against one item, i.e. the raw material received from the material store, and the finished product received from the shops, as in the case of a rotor shaft, etc.

The sub-store record, i.e. the specification list, furnishes admirable data for the department foreman and also for the progress chaser, for the items not received are clearly shown. Parts received are stored in assemblies, all those required in connection with one order being kept together, this, of course, referring to such parts as are ready for assembling. The rough parts requiring machining are kept in one section of the store, the parts in process in another, and parts are issued to the shop upon receipt of a workman's order card, or a requisition signed by a responsible person.

The sub-store influences the working of the manufacturing department in no uncertain manner, for if it is properly conducted, vexatious delays consequent upon material being mislaid will not arise. There is also little fear of missing parts being overlooked, for the storekeeper is in close touch with the department chaser, and gives him due warning of the requirement of any specific part.

These departmental sub-stores, although included in the progress organization, are not under the direct control of the head storekeeper, whose authority extends over those departments comprising the Works Stores. The sub-stores are controlled by the department head chaser who, in turn, is responsible to the progress manager.

Whilst dealing with the storage facilities of the factory we cannot omit the Commercial Store, an extreme wing of the store organization, associated rather with the sales side of the business than with

the works. Its interests are varied, although concerned with the manufactured unit rather than with detail, and its functions may be classified as follows: (1) the storing (or warehousing) of manufactured goods pending sale ex-stock; (2) temporary storing of specially manufactured goods pending the receipt of dispatch or shipping instructions; (3) handling all repair work received from customers; and (4) packing and dispatch.

Where assembled units are manufactured entirely for stock, the Commercial Store (or warehouse) is designed for the accommodation

STOCK RECORD CARD OF COMPLETE UNITS READY FOR SALE

Article	Catalogue No.	Maximum
		Minimum

Date	Stocks			Day Book or Order No.	Date	Stocks			Day Book or Order No.
	In	Out	Balance			In	Out	Balance	

Fig. 62

of definite quantities of each class of apparatus stocked, and the mode of procedure is similar to that ruling in the Works Store. The stocks are maintained upon a maximum and minimum basis, the posting being shown on stock cards which are filed consecutively under catalogue numbers. As orders are received from the Sales Department the cards are adjusted, and the necessary information passed on to the stockkeeper, who supplies the goods to the Despatch Department.

When the stocked quantity is down to the minimum figure, an order is sent to the Progress Office for further supplies, copies of this order in the form of assembly lists being sent to the manufacturing department concerned, and to the works stores. When the manufacturing department has completed its work, the goods (after inspection) are sent direct to the Commercial Store accompanied by a delivery note. There the quantities are checked, the

goods placed into stock, and the delivery note (signed by the stockkeeper) sent to the clerk for the receipt to be recorded.

It sometimes happens that, although a certain standard article is stocked, it is not in itself a completed unit, certain additions being necessary before it can be dispatched to the customer. A case in point is the travelling pulley block, the hoist (already assembled) being stocked, whilst the traveller portion has to be fitted to suit the customer's requirements. Upon receipt of an order for one of these articles, a requisition is sent from the Commercial Store to the Progress Office, to supply and fit the necessary parts—particulars of these parts being given. The Progress Office issues the instructions to the manufacturing department concerned, and the foreman of this department requisitions the hoist from the Commercial Store, and the other details from the Works Store. When the work is completed the unit is sent to the Commercial Store, and thence to the Despatch Department.

The composition of the Commercial Store for the temporary storing of special assembled units is different from the foregoing for, in the strict sense of the word, it is not a store at all. To illustrate its function let us assume that an A.C. motor, built to the customer's requirements, has passed inspection and been sent to the Test Department. Having passed the requisite tests, the unit is delivered to the Commercial Store to await the dispatch or shipping instructions.

No elaborate records are necessary, the store offering but temporary accommodation. A record is made of the serial number of the unit, together with the date of receipt, and the delivery note which accompanied the unit to the store is sent to the Sales Department. In due course shipping instructions are received, and the unit is passed to dispatch.

In some cases the unit forms part of a set which comprises, say, an A.C. motor, controller, and resistance, each being manufactured in a different department—and it may be, therefore, that one of these arrives in the store in advance of the others. As the whole set must be dispatched to the customer at one and the same time, the first arrival must remain in the store to await the others, and the storekeeper, therefore, must be conversant with the terms of dispatch, this being made possible by a copy of every order being sent to the Commercial Store from the Sales Department.

Units received into the factory for repair or overhaul are sent from the Receiving Department to the Commercial Store. The question

DAILY DESPATCH LIST

GOODS DISPATCHED ON *Wednesday*, 16*th February*, 19....

Package No.	Consigned To	Address	Contents

FIG. 63

of inspection in the Receiving Department does not arise in this instance, as obviously the inspection of such parts is in conjunction with the estimate for repairs. The Commercial Store has a qualified engineer for repair estimate inspection, and he issues the necessary instructions.

If the volume of work permits, there will be a department exclusively engaged upon repairs, and all instructions are issued direct. Should there not be a Repair Department, then a section is set apart for this work in one or more manufacturing departments, but, in this instance, all instructions are sent via the Progress Office, it being unwise for one foreman to receive manufacturing instructions from more than one source.

The final store department is the Despatch, with which is associated the Packing Department and, in some instances, the case making shop also. Instructions to dispatch are received from the Commercial Store, all the necessary information being given. The clerk in this department compiles a Daily Despatch List, giving a brief record of all goods leaving the factory, copies of this being sent to the Commercial Store, Sales Department, and Progress Office.

CHAPTER XXVIII

THE TOOL AND BLUE PRINT STORE

THE Tool Store is not usually associated either with the chief storekeeper or with the Progress Department, it being considered part of the tool room organization. In the case of tools in bulk quantities purchased from outside, these may be held in the Main Store, and requisitioned by the tool storekeeper as required. These tools, it will be observed, have already been passed by the tool inspector prior to acceptance into stock, and so the tool storekeeper can assume that, from a utility standpoint, these are quite in order.

Tools in bulk are recorded upon stock cards, such stocks being kept upon a maximum and minimum basis. This, of course, refers to standard tools, the basic figure for each type being determined, in the first instance, either by the chief tool maker or by the head of the Planning Department, it being understood that no charge can be made except with the sanction of this individual.

The tool storekeeper holds a certain "live" stock of standard tools, this stock being replenished by the Main Store upon receipt of a requisition. The requisition is usually a weekly matter, the tool storekeeper overhauling his stocks and placing a requisition upon the Main Stores for renewals. The stock record cards are posted in accordance with this requisition, and when the minimum figure is reached instructions are sent to the Purchasing Department for renewals, no notice being taken of the stocks which may at the moment be in the Tool Store.

This has the effect of ensuring adequate supplies being always available, as the following will show. For one type of file the minimum figure is 36, and at the moment the record card shows 72 in stock. A requisition for 36 is received from the tool storekeeper, and this quantity, being deducted, brings the stock down to the minimum figure, and the Purchasing Department is instructed accordingly. It will be observed that, although 36 have been withdrawn from the Main Store, they are still in existence, as none of the files has been put into commission, but for ordering and stock purposes this fact is not considered. It is expected that the tool

storekeeper will exercise sufficient judgment to keep his stock within reasonable limits, and this being so, the chief storekeeper is concerned wholly and solely with his own stocks.

Special tools, or tools not ordinarily stocked, are requisitioned from the Purchasing Department by the chief tool maker, or the head of the Planning Department, whichever may be responsible for this class of work. These goods, when received, do not go into the Main Store, but are inspected by the tool inspector and passed direct to the Tool Store.

Tools, jigs, etc., made or repaired in the tool room are sent to the Tool Store after inspection, and in this connection it may be observed that, just as nothing can be received in the Main Store without first passing inspection, so also can nothing be received in the Tool Store until inspection has been carried out. Every tool or jig in the store must be ready for use at any time—there must be no question of an operator being refused a tool (if this is in store) on the grounds that repairs are necessary; neither must there be given an operator a tool which is not in a good state of repair.

The Tool Store is the distributing agency so far as tools are concerned, and the method of distribution may be divided into two classes. The first deals with what may be termed the tools issued "on loan"; that is to say, the operator proffers a check and receives the tool he desires in exchange. The check is retained in the store, until such time as the tool is returned, when the check is handed back to the operator.

A system which is very much in favour is the following: Each operator has a number (say, six) of brass checks, each check being stamped with his clock number. Desiring a tool or a jig, he arrives at the Tool Store, and writes upon a tool ticket the number of the tool desired, together with his own name and clock number. This tool ticket, together with one brass check, is handed to the storekeeper, and the operator receives the tool in exchange.

The storekeeper has a card file, one card for each clock number, these being arranged consecutively, and the tool ticket is placed behind the card bearing the corresponding clock number. By this method the storekeeper can tell at any time the number and the names of every tool held by a certain operator. The brass check is placed upon a hook affixed to the locker from which the tool has been taken, and assuming that another operator subsequently

desires the loan of the same tool, a glance will show the storekeeper that this is already out, and in whose possession it is.

When the tool is returned to the store, the brass check and the tool ticket are both handed to the operator, and the tool, before being placed into stock, is sent to the tool inspector. A note accompanies this, and a copy of the note is placed in the locker, where it remains until the tool is received back from the inspector, when it is taken out and scrapped. The original note which went to the inspector with the tool is endorsed by the inspector, and placed on file in the Tool Store.

TOOL TICKET

Date ....

Check No. ....

Operator's Name ....

FIG. 64

Where a set of tools is reserved for one specific job (say, a sub-assembly) the tools are kept in a box, and the whole is treated as one tool; that is to say, one check is sufficient for the whole set, even though this comprises a dozen different tools. A list of the tools comprised appears upon the lid of the box, and whenever a box is returned from the shops the contents must be checked by the storekeeper.

Drills, taps, etc., of the smaller sizes may be handed out on check, or upon a foreman's requisition. If the check system be favoured, a certain number (say, five) may be issued upon one check, a note being made of the number returned and the condition they are in. This, however, entails a lot of work, and the better method, perhaps, is for the foreman of the Drilling Department to requisition

supplies from the Tool Store, and to hold a small stock of these parts in his own department.

A record is made of all small tools issued in this manner, a report being sent to the works manager or the head of the Planning Department periodically, showing the number of tools requisitioned during a certain period. The tools are re-issued to the operators by the foreman, and the latter, through close association, is able to check any extravagance or carelessness. Further, it may be observed that the foreman knows the requirements of a specific job—whether a long or a short drill can be used, etc., and in this way economical distribution is assured.

OPERATOR'S TOOL ON LOAN CARD

Name.. Clock No. ....

Tools Issued				Returned	
Date	Quantity	Size	Description	Date	Recd. by

Fig. 65

The other class of tool distribution is the exchange system, or renewals. Certain operators, such as assemblers, bench hands, etc., have, in the first instance, a number of tools allotted them, these including files, hammers, chisels, etc., and in course of time renewals are necessary. When the operator starts he is given a "permanent kit," together with a card enumerating the tools comprised, and this he signs and retains. A further card giving the same particulars is also signed by the operator, and this is held in the Tool Store. When the renewal of a tool is necessary the operator

obtains a note from his foreman, and hands this, together with the worn-out tool, to the storekeeper, receiving in exchange a new tool of a similar class. No alteration is made upon the tool card, for the operator still holds tools in accordance with the details thereon. The storekeeper will not issue a new tool upon receipt of a foreman's note only. The old tool must be presented.

RECORD OF TOOLS LOANED

TOOLS LOANED TO

Name.. Clock No. ....

Issued					Returned	
Date	Quantity	Size	Description	Operator's Signature	Date	Received by

FIG. 66

Should an extra tool be desired, a foreman's note must be obtained, this being endorsed "extra tool," and the operator must present this, together with his tool card, to the store. The storekeeper will thereupon add particulars of the new tool, together with the date, upon the operator's and also the store tool card, each card being signed by the operator.

Usually associated with the Tool Store is the the Blue Print Store, each print being issued to the shop upon receipt of a blue print or drawing ticket, bearing the number of the drawing and the operator's name and number. A card record, each card bearing the number of the drawing and filed consecutively, is kept in the Blue Print Store, the withdrawal ticket being placed behind the card bearing the number of the drawing taken away. When the blue print is returned the ticket is handed back to the operator.

The face of the card is used for recording withdrawals by, and re-issues from, the Drawing Office. No blue print can be recalled without a written notification, and this must be signed by the

DRAWING TICKET

PLEASE ISSUE BLUE PRINT—
Number ....
Operator's Name ....
,, Number ....
Department ....
Date...........................

FIG. 67

Drawing Office messenger before he can receive the blue print. When this is returned to the store, or another print issued, this is signed for by the storekeeper, the date in each instance being recorded. All this is entered upon the card bearing the number

BLUE PRINT RECORD CARD

B.P. Number...............................

(All withdrawal Tickets to be placed behind card.)

BLUE PRINT RECORD

Date Received	Date Recalled

FIG. 68

of the drawing affected, and the whole forms a comprehensive record.

As has been implied, the tool storekeeper can, in many factories, exercise control over the Blue Print Store, a separate window being provided for the distribution of all drawings.

CHAPTER XXIX

THE PROGRESS MANAGER

As the reader approaches the end of this Part, many omissions will no doubt occur to him, and he will protest that the matter is incomplete, his objections being in accordance with the phase of factory organization in which he is intimately concerned. If an accountant, he will protest that costs and accounts have been too lightly regarded, whilst the engineer will see the importance of matters of interest to him overshadowed by what he may term the "clerical interests."

As explained at the commencement, however, this volume does not pretend to deal with costs and accounts, but it is contended by the writer that the principles expounded will materially assist efficient costing. When all is said, cost is the basis of the organization; and, unless this fact is observed, organization is obviously of no avail. The system of costing does not interest the man in the factory, but he is interested in keeping his own costs down to the lowest figure proportionate to his production.

Administration is portrayed as a separate entity, and is represented chiefly by the progress organization, bringing practically the whole of the factory administration under one central control. This obviates multiplicity, and must as a consequence simplify costing. Stores, progress, purchasing, transport, with the clerical and manual labour involved, are not split up into a dozen different factions, but all form part of one organization under the supreme control of one man—the Progress Manager.

It is with this individual that the book is chiefly concerned—what he is doing, and why. Other interests of necessity are brought in, but only to show their relationship. The Drawing Office is considered because it is an instruction department—The Planning Department, as being responsible for the Shop Lay-out. The Progress Manager must work upon what is in existence. He does not create—but he voices the need, and once that need is supplied he must take full advantage of it.

It is bringing the commercial spirit into the shops, and letting

the engineer see exactly what is wanted. Increased production is required, but not at any price. The question of cost is ever to the fore, and it cannot be ignored. To increase production new tools are made, but is the cost justified? An efficient factory system shows this.

The engineer is concerned with production, and the means to produce. Apart from the direct means, the progress manager provides the facilities. Whoever is responsible for the manufacturing programme, it is the business of the progress man to ensure this being adhered to. If the lay-out of the shop allows for a certain production, the necessary material must be available at the right time for each manufacturing section, otherwise the shop fails in its endeavour.

The section foreman cannot accept administration responsibilities, for he is there as a producer, and to be a success he must concentrate. The wider his interests, the less chances of concentration there are, and results are affected accordingly.

The duties of the progress manager are clearly defined. He is there to ensure that the capabilities of the manufacturing departments are fully exploited, and to eliminate waste. He controls the clerical labour in the shops and prevents duplication. He controls the store and ensures adequate supplies, at the same time avoiding excessive stocks. He controls purchasing, and is able to buy economically by getting what is required at the right time, and he controls departmental progress and transport, offering every facility to economical manufacture, and providing the records which are necessary for intelligent costing.

The matter is incomplete, and must be so from necessity; but sufficient has been written to show the value of the administrative side of the factory organization. It has not always received the attention it deserves, and if this volume succeeds in exciting the interest of those upon whom the future of industry depends, then the labour expended upon it has not been in vain, and the author is satisfied.

PART II

CHAPTER XXX

FACTORY BUILDINGS

In the first part of this book has been described a complete system for the administration of an industrial organization, showing how the factory work, from the receipt of the order, through the buying of the raw materials and its progress through the shops, flows in an orderly manner and under proper control to the ultimate delivery of the product to the customer. In this second part attention is turned from the administration of the manufacturing departments, to the primary matters of the buildings and plant with which this production is attained. To many established businesses these will be matters in which modification will be difficult since the plant is already installed, but even to these the ideal arrangements can be indicated to be adopted as extensions or alterations become necesary.

Every business will, of course, have its own special problems, and there can be indicated here only those general points common to all. The matters to be dealt with will in every case be described as if a new plant is being laid down, and those factors to be considered by the management detailed in order to obtain maximum production at a minimum cost.

Site for the Factory

The first matter for consideration at the outset is the best location for the industrial plant. To many businesses there will be deciding factors so strong that the choice is severely limited, as, for example, in the extreme case of a mine or quarry, but to others the following factors will have to be considered and their relative values weighed carefully according to the nature of the product and the business. None is so unimportant that it can be entirely ignored.

(*a*) *The Source of Raw Materials.* It is an obvious gain for the business to be located as close to its supply of raw materials as possible unless the cost of transporting is low enough to negative the pull of this factor. Thus, in the case of the iron and steel industry, the chief raw materials are iron and coal—bulky, heavy

goods, whose cost of transport is high—so that this factor of their source was probably a deciding factor in the establishment of the engineering area of the Midlands.

The original source must be considered with due regard to its stability and the possible future introduction of any substitutes. If the raw material required is the product or by-product of another industry, then the question resolves itself largely into a consideration of the establishment of that other industry and its probable future trends.

Included in this question of raw materials is the ancillary one of the cost of transport, since the cost of the raw material must include the cost of delivery to the works. If cheap permanent means of transport exist, the location of the factory may be moved accordingly. The building of the Manchester Ship Canal is an example of the application of this cheaper transport factor assisting the development of the Manchester industrial area.

(*b*) *The Situation of the Market.* Just as the pull of the raw materials affects the location of the factory site, so does the place where the finished product will have to be delivered before it is sold. Similarly, the question also turns largely on the question of the cost of carriage. If the product is a bulky one (e.g. metal boxes) or highly fragile or perishable, then it is most advisable to manufacture in that place where the goods will travel the shortest distance to the market, unless the value of the product is so high that it can stand the high cost of transport. An industry intending to supply a widespread market would find the geographical centre of that market best, having regard to the varying costs of transport to different parts of the market. In one case, a business was situated in the north of England to supply a market in Yorkshire. A large part of its raw material was obtained from London. After a few years it discovered that its sales covered the whole of the country so that another branch was established in the north suburbs of London, more nearly central to its new market. This branch so quickly developed that the original factory was closed when it was found that the gain in transport expenses by delivering from this more central depot more than covered the cost of moving, while the gain in prestige by reason of more rapid deliveries was considerable.

(*c*) *Labour Factor.* From materials we turn to the second factor

in production, Labour, which also plays a part in deciding the factory site, for there must be an adequate supply of workers for the factory. The workers can generally be classified into male and female workers of either the skilled class or the unskilled. Of these four groups it will generally be found that the skilled male worker is fairly mobile and will come to the site of the factory which will provide him with employment providing there is reasonable housing accommodation, but this is not always the case with the other type of workers, so that our site must be where such a supply is at present available if we are requiring these classes of workers.

One will generally find that, in the crowded industrial area, with a plentiful supply of labour, wages tend to be low with the keener competition for employment; yet, at the same time, the trade union control and interference is generally stronger in the town and crowded areas than away in the rural sites. It is interesting to notice how the environment of the site will be quickly reflected in the attitude of the workers. A factory situated in the country with no social amenities for its workers—no theatres, cinemas, etc., will quickly breed discontent amongst them unless some form of amusement is provided by clubs and recreation rooms; even the higher placed officials will feel the effect of the lack of schools and other amenities of the towns. It is, furthermore, a good plan to choose the site with regard to the type of businesses already there, thus a manufacturing business in a manufacturing area where trained workers with the inherent mechanical instincts of the district are abundant, and where there are other businesses available to absorb them if necessary so that they do not leave the district should a temporary period of inactivity be experienced. The cost of training new workers drawn from these areas of inherent skill will be materially lower. Yet, with the development of automatic and semi-automatic machinery, this factor of the skilled worker is not so important as it was in the past, and this, together with the improvement in transport facilities for workers, has made possible the increasing use of suburban and rural sites, where semi-skilled and unskilled labour can be obtained from the locality and from neighbouring towns.

(*d*) *Transport Facilities.* It has already been shown in considering the source of raw materials and the location of the market, how the cost of transport will be of material effect in choosing the site,

especially if the goods are heavy or bulky. The nature of the business will, of course, affect the interpretation of this factor, e.g. two factories in London, one, a flour mill, receives its raw materials from river lighters and delivers by its own road vehicles, and is situated on the riverside with a private wharf and against a main road, while the other, dealing in chemical products, receives its raw materials by rail, but the majority of its product is distributed through the post, so the site is placed in the suburbs on the railway-side with a private siding. Hence, the actual form of transport best adapted to the nature of the business, whether road, sea, canal, rail or air, will affect the decision on the site question.

When considering rail transport, if this is of any magnitude, it must be remembered that the chief delays arise not in the actual transport but in the terminal loading and unloading, so that a private siding, including provision for both empty as well as loaded trucks, will often prove a saving. The proximity of water transport, whether sea, river, or canal, also means a cheap source of water for boiler or process use.

It must be recalled that the charges of the rail and canal companies are on a sliding scale, varying with the nature of the goods, so that raw materials can usually travel under a cheaper classification than can the finished product, thus increasing the pull of the market on the site location if their relative bulk and weight do not materially differ. The possibility of any specially reduced contracts with transport concerns will be a further consideration in attracting the site to any particular form of transport.

(*e*) *Power*. It is important to have an adequate and reliable source of power. Where this is derived from coal used for steam raising, while it is not so important to be on top of the source of supply, since the slightly higher cost of transport will hardly be of much effect, yet it is necessary to be located where the supply will be reliable and regular, as otherwise it may be necessary to go to the expense of retaining a reserve store of coal.

The modern tendency in industry is to use electricity for power purposes because of its ease in handling, flexibility, cheapness, etc., and the increasing availability of electricity supplies by the extension of the grid system has made the power factor of less importance in choosing the factory site and has been one of the reasons for the development of many new factories in rural areas.

It is convenient to mention here the necessity for a suitable *water supply* to the industrial plant. For certain industries which require large amounts of water for process purposes, this matter will assume greater importance not only as to quantity but also as to its quality, i.e. its chemical suitability for the industry. It may be obtained from local authority supplies, or from canal, river or lake, while, failing these, a cheap supply can often be obtained by the sinking of a private artesian well. In the first case, the cost of purchase will be the main factor; in the others its purity and regularity of supply, for the natural source may disappear in summer so that storage must be undertaken.

(*f*) *Cost of the Land.* Where the land is being purchased, its cost is usually not a factor of much weight, since the advantages accruing from the other factors usually outweigh that of any variation in its initial cost. But the cost of any charges such as ground rent, rates or taxes must receive consideration as part of the running expenses of a business on that site. It is essential that *sufficient* land be bought, not only for immediate requirements, but to cover all possible future requirements of expansion, otherwise when later the factory is to be extended, it may be impossible to get additional adjoining land, or if it is available it may have to be bought at exorbitant prices. Of course, the mistake must not be made of buying too much and so locking up capital in unnecessary assets.

(*g*) *Local By-laws* may possibly prohibit the carrying on of certain businesses in the area contemplated. In some cases the local authorities have power of imposing stringent regulations on manufacturing concerns within their area, so that it is often wise to shun these for those with greater freedom, especially where the business to be carried on is one which might by any chance be called obnoxious to the surroundings by reason of fumes or any other cause.

(*h*) *Waste Disposal* to many businesses is a troublesome problem unless satisfactory sewer connection or river outlet is available for the disposal of liquid waste; while solid waste of ashes, etc., is a still more difficult problem unless there is a dump available or extra land has been bought for the purpose of a dump. Where the waste is at all offensive, then this question must be solved, else it will result in difficulties with neighbours as well as re-acting on the health and well-being of the workers.

(*i*) *Fire Protection.* It must be remembered that if a plant is installed outside of a town or near to some other dangerous business then, unless it is one where the building is fireproof and the process one not liable to fire, a private fire-fighting service must be maintained. This means not only the personnel but also a sufficient pressure of water for the hydrants. This factor will be reflected in the fire insurance premiums chargeable and the cost of upkeep of these fire-fighting facilities.

(*j*) *Natural Conditions.* The site must be finally considered by a surveyor with regard to its topographical features. The nature of the soil for foundations, the drainage, possibility of subsidence, or flooding require the opinions of an expert. Where the site is on a hill it may be possible to take advantage of the contour in planning the works for gravity flow of material from one process to another to reduce internal transport charges.

So any business can choose its ideal site only after a full and comprehensive survey of the whole of the above factors in the light of the exact requirements of the business in question, since its nature will determine their relative importance. The sum total should then indicate that site which should prove to be the most satisfactory.

Types of Buildings

The site having been chosen, the next consideration is to decide the nature of the building which is going to house the plant and the workers in such a fashion that it will result in maximum production. This decision will depend entirely upon the nature of the business and the special requirements of the processes. It is often wise to avoid, if possible, the introduction of special elements into the building design, as this may prevent its adoption for any other business and so lessen its market value if it should be desired to realize it at any future date. The size and local conditions of the site, as well as the nature of the process and plant involved and the bulk of the finished product, are factors to be considered; while the restrictions of the Factories Act, 1937, on matters such as lighting, ventilation, and the welfare of the workpeople must be observed. There may also be local by-laws regarding buildings in the district to be borne in mind.

The first step is to get some idea of the size of a building required

by carefully listing the various machines or processes, the several store-rooms, offices, canteens, etc., which go to make up the complete works. Then comes the question, shall it be a single-story building, or one of several stories?

Single-story buildings are a necessity in those industries using very heavy machinery, such as foundries and heavy engineering works, or where vibratory machinery is in use as in the weaving sheds of the textile industry. They have the advantage that it is possible to use roof lighting and take full advantage of natural light. There is also a total absence of vibration, while, in addition, it is often contended that supervision over the workers is much easier where they are all on one floor than when they are scattered in several rooms and floors. From the point of view of cost, there is an economy in space by the absence of lifts, stairways, supporting pillars or walls, as well as the avoidance of the expense of lifts from one floor to another, while the actual construction is cheaper, since the foundations, walls, and floors may be lighter than in multi-story buildings.

In congested areas, the value of the land may make the multi-story building a necessity, though in certain industries the advantages of being able to use a simple gravity feed of materials from a process on one floor to that on a lower floor are so great that a multi-story building is always used. This is clearly exemplified in the brewing industry where the hops and malt are all hoisted to the top floor for entering into production, and then flowing through the cleaning and grinding processes to mix with the water and so to the boiling vats, whence it is run down through cooling pans, fermenting tanks, etc., to the final barrelling and bottling in the cellars, gravity providing the motive power in almost every case. Another argument in favour of the several-story building is the economy in the heating of a building with a less relative area of outside wall and roof to the floor space.

There is next to be considered the type of construction of the building itself. Four main classes are available, brick, steel frame, concrete, or timber, and the one to be adopted will be decided after a consideration of such factors as the durability and the probable length of the occupancy, the nature of the processes and of the materials to be handled, the fire risks, the machinery to be installed, the speed of erection and the cost of the alternative types.

Brick. The majority of the older buildings were made of brick, with the side and interior walls carrying the weight of the upper floors and roof so that where any considerable weight had to be borne they had to be made fairly thick with frequent re-enforcing pilasters. This means that the window space in these walls cannot exceed 50 per cent of the total area of the wall with the result that the natural lighting is very poor. The modern development in brick buildings is to introduce steel framework to take part of the stress so that the walls may be made with greater window space.

Steel Frame. This modern method of building is speedy and effective and is used for both single- and multi-story buildings. Steel truss roofs and steel joist floors are built into a framework composed entirely of steel girders and beams which have been cut and drilled before delivery to the site, where only assembly is necessary. The entire stress and strain is taken by this skeleton structure; the walls, being merely casings or divisions, can be constructed of brick, concrete, tile, masonry, etc., leaving up to 90 per cent of the wall area available for lighting. In many cases it is necessary to encase the steel frame with cement plaster as a fire protection against bending by heat, though otherwise the structure is fireproof. The cost of this type of building is low, and it is possible to make alterations and extensions without very great trouble.

Concrete. With the great uses to which concrete is being put to-day, it is not surprising to find large blocks, slabs, or bricks being made of concrete on the site and the building being constructed of these in much the same way as brick buildings from which this type of building does not substantially differ. By the term "concrete building," however, is more generally meant reinforced concrete, a method which is being used very extensively for industrial buildings. The walls and floors are made of concrete with steel rods embedded in the wall to take the stress. In the hands of a specialist the construction can be both rapid and effective, the wooden moulds being built on the site, the steel rods inserted, and the concrete poured in to set. The building may be entirely made of reinforced concrete or alternatively only the framework so composed, the walls being filled in with brick or other material. The advantages of this type of building are in the first place the relatively low cost of construction, providing the site is reasonably

near to a source of building materials. It will be found to be fireproof and rigid, while, with such a large window space, the increased lighting allows the floor area between the walls to be made greater. It is extremely simple to extend such a building either by adding another story or by further extensions. On the other hand, by reason of the concrete material, which is a good conductor of heat, as well as by reason of the increased window space, these buildings will be found to be cold and will involve much greater expense for heating. Great care must also be made when building to provide for all shafting, vents, pipes, etc., which may have to pass along or through the walls, since it is extremely difficult to cut into the concrete,while the cutting of doors or stairs may be almost dangerous in altering the stresses in the walls.

Timber. For certain purposes a wood building may prove suitable where a small cheap erection is called for, provided that, because of the building material, the process involves a low fire risk. It must not be overlooked that in view of the fire risk there are often restrictions in local authorities' by-laws regarding wooden structures. It will need to have proper maintenance in the form of regular painting or creosoting.

Whatever type of building is chosen there must be, first of all, a good foundation, and borings of the site should be taken before commencing to build. Thus, a foundation of clay or chalk will not be satisfactory, since it is both damp and of low bearing power. The best natural foundations are rock or gravel, though such sites are rarely available. If the natural foundation is not satisfactory, it will be necessary to make an artificial one, usually a bed of concrete at least 10 in. deep, and spreading several inches on each side of the supported wall. If the site is inclined to be at all unstable, then the foundation may be of concrete beams following the walls with a complete layer or raft of concrete over the top.

The type of flooring will depend on the nature of the building, whether factory or office, warehouse, or entrance hall. In every case it ought to be smooth, dry, noiseless, non-slipping, and be capable of bearing five times the load which may be placed upon it. The more common types of flooring are: Concrete, which is cold, noisy and dusty, but forms an excellent base for other types of flooring such as wood block floors which have many points in their favour. Concrete floors are liable to get damp by condensation of moisture

from the air and are often covered with a thin layer of asphalt composition, giving a quiet dustless floor with excellent wearing qualities. Brick or stone floors tend to get uneven as well as being cold.

There are three types of roofs available, the flat roof, the A-type, and the sawtooth. The flat roof, which is most common in the reinforced concrete buildings, is like an extra floor and may be composed of concrete or covered with asphalt or zinc, supported by the usual beams in the same manner as the floors but at a slight slope to allow drainage of rain water. The familiar A-type roof which does not require many supports other than the outside walls will allow a wide space beneath it clear of all supports. Where roof lighting is to be adopted, the sawtooth type will be found the best, avoiding direct sun, but giving maximum light by reflection

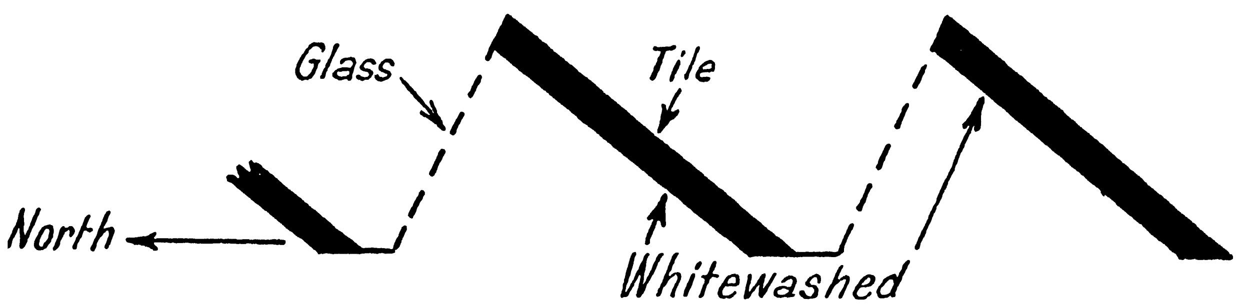


FIG. 69. SAWTOOTH ROOF

on the whitened surfaces through the upright windows, and so designed that the glass faces northward to avoid the glare and heat on the glass (Fig. 69). In choosing the roof-covering material regard must be had to—

(*a*) Waterproof qualities, since its first function is to withstand the weather, including the severe test of melting snow. Furthermore, as in many districts the rain water is slightly acid, it must be impervious to this action.

(*b*) Weight, since the load must be reduced as much as possible, so that preference should be given to light durable materials.

(*c*) Heat resistance for, it must keep as much heat in or out as possible to avoid the variations between inside and outside temperatures.

The more common materials used are slates, tiles, galvanized iron, and bituminous felts.

Heating of the Building

If not regulated, the temperature within a factory will quickly react upon the efficiency and output of the workers, a temperature

too high causing lassitude and too low, discomfort, so that a proper understanding of the best temperature is first necessary. This will depend on the nature of the work being done, that requiring activity on the part of the worker needing a lower temperature than the work done in a continual sitting posture. In a similar fashion, if the work requires or results in a high humidity of the atmosphere, e.g. textile industry, or laundry, then a lower temperature should be maintained than in a factory where the air is dry. Thus, in textile works a temperature of approximately 60° F. is required; in an office about 70° F.; in a foundry about 50° F.; in a machine shop about 63° F.

The amount of heat which is to be supplied to a factory depends on the amount of heat which is lost through the walls, windows, and roofs as well as by ventilation, etc. Hence, the problem must be approached by an enquiry about the heat losses, i.e. about the conductivity of the materials composing the walls and roof. Concrete, of the more usual building materials, has the highest conductivity, being over twice that of a plain brick wall. If the brick wall is plastered on one side with a slight air cavity left between the brick and plaster, in the fashion of the usual house walls of to-day, the heat losses will be reduced by 30 per cent. In the case of solid wood or hollow tile walls the heat losses in both cases are approximately 50 per cent more than that of plain brick walls. The heat lost through the windows is enormous, being more than six times that of a plain brick wall, though if double sashes are used this loss is reduced to about 2½ times that of a brick wall. The flooring and ceiling also account for a certain loss which is approximately equal to that through a brick wall, and a wooden flooring and unplastered ceiling to roughly twice as much as where the ceiling is plastered. The heat losses by ventilation will depend on the system adopted and will be measured by calculating the number of times the air in the room is completely changed each hour.

From these factors it is possible to calculate the total hourly heat loss in thermal units, and from the total will be deducted the total heat generated from the various sources in the room. Thus, every person in the room is giving off heat into the atmosphere, and it is calculated that a person actively engaged gives off 500 B.T.U. per hr. while a man sitting down gives off hourly about 400 B.T.U. Motors and all machinery in motion in the room are giving off

heat, as a certain amount of energy is lost in friction. The lights, whether gas or electric, emit heat into the atmosphere, and there may be other sources of heat in particular processes in the room.

The amount of heat the heating apparatus is to supply to the factory to retain the required temperature must be calculated after taking into account the total heat lost less the total given off within the room.

The systems available to supply this heat are roughly four in number: the direct steam method, the hot-water system, the indirect steam method, and the open fire method.

In the direct steam method, the exhaust steam from the power plant, supplemented by live steam from the boilers in the winter, is led through pipes and radiators through the factory so that it can give off its heat into the room. In the case of small installations the one-pipe method is used, the condensed steam running back down the pipe to the boiler. The larger installations adopt the two-pipe method with the steam flowing round the system in a circle either by gravity or mechanically circulated.

Some plants use the exhaust steam supplemented with live steam from the boilers to heat water, or alternatively a water boiler may be installed to heat water which similarly passes through pipes and radiators, circulating round and giving off its heat. Water systems, however, require a much greater heating surface since the difference in temperature between the pipe and the atmosphere is not as great as in the direct steam method while the system takes longer for the same reason to heat up the works. When the works are closed there is also the possibility of freezing, though it must be said in favour of water systems that they certainly require much less attention than the steam system and keep the factory more evenly aired.

The indirect heating systems comprise a number of coils of either steam or hot water pipes in a duct, through which fresh air is drawn and blown into the room. Any humidifying or air cleaning apparatus, etc., can also be introduced into this duct where the processes require it. This system has the advantage that it aids ventilation and, besides keeping the room more evenly heated, is more efficient in that a higher percentage of the heat from the system gets into the room than in the other methods. It will be noticed, too, that by forcing warm air in, the other leakages will

be outward, so that cold draughts are prevented. Incidentally, it is simple to modify this apparatus for cooling the air in summer.

The open fire methods are definitely unsuitable for modern factory conditions, so that they are rarely used except in the smallest of shops and need not receive further mention here.

Ventilating the Factory

Under the Factories Act, 1937, every room of a factory must be adequately ventilated that the air may be kept pure and fresh. Yet, apart from this legal enforcement of the principle of ventilation, since it has such a rapid reaction upon the output and quality of the work, no business man would overlook this vital matter. It is interesting to notice that the modern viewpoint lays as much stress on keeping the air moving in the workroom as to the actual changing of the air since by the movement, the cooling power of the air is retained.

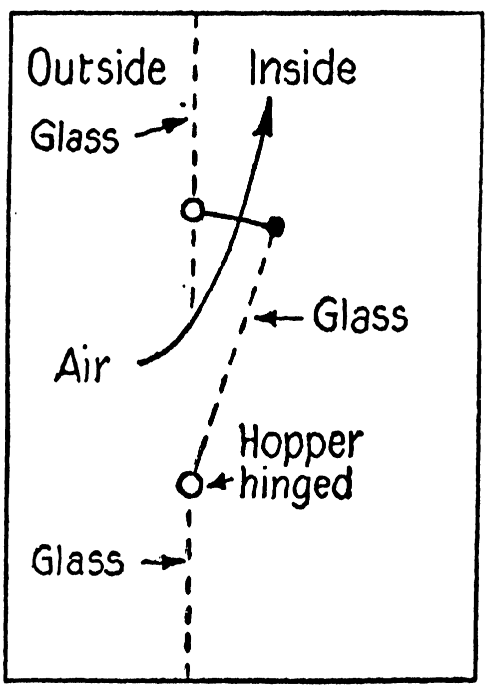


FIG. 70. VENTILATING WINDOW HOPPERS

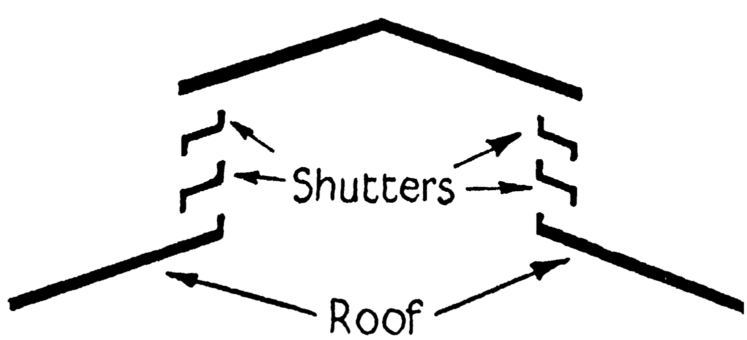


FIG. 71. ROOF VENTILATORS

The amount of ventilation necessary will vary with the work carried on, as when the processes are hot or emit fumes they must be cleared away. Under normal conditions the air in the room should be changed completely at least six times per hour. This should be attained without any draughts on the workers, but yet so that it is effective over the whole of the floor area.

The system of ventilation may be either natural or mechanical. The natural system is effected by the movement of the air due to its differing density as compared with the outside air aided by outside wind currents. The rooms may be provided with flues or ducts opening on to the outside and leading the air into the room

at a point midway up the walls. The windows may be fitted with hoppers (Fig. 70) with the opening shielded and pointing upwards so that rain cannot blow in while the incoming air is directed off the workers. Where the factory has an outside roof, ventilators may be fixed there with movable shutters to control any excessive draughts from adverse winds (Fig. 71). These work most effectively and are in common use in those factories where there are process fumes to be extracted, such as steam, etc. Other types of roof ventilators are of the metal cowl type bent over, with a blade to revolve the cowl so that no direct wind is directed down, but the vacuum caused by the passing wind draws the air up. (Fig. 72.)

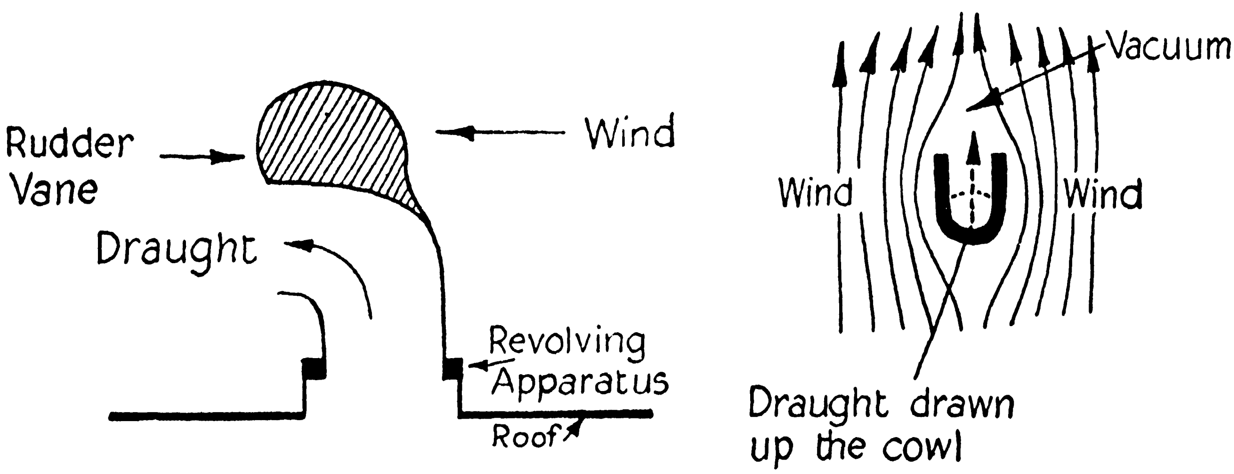


FIG. 72. COWL VENTILATOR, SHOWING VACUUM CAUSING UPWARD DRAUGHT

These natural methods of ventilation often have to be helped to provide sufficient ventilation by mechanical means, the commonest being the electric fan which will keep the air moving, either circulating within the room or moving along a duct. It is interesting to notice that exceptionally high speeds are not necessary to obtain the highest efficiency from a bladed fan in moving the air; it is more important to see that there is a free uninterrupted flow both to and from the fan. This means that ducts should be as large as possible, straight, or with very gradual curves with no projections which can stop the flow.

The mechanical methods of ventilation may be either removing the bad air from the room and allowing the good to be sucked in as the other is extracted, or alternatively forcing fresh air in while the bad leaves through crevices or outlets provided. The "in" and "out" points will, of course, be placed so that the flow of air will be naturally across the room, as if the air is allowed to be

"short circuited" the whole effect will be lost. The ducts through which the bad air is being drawn out must also be large enough to allow the fan to work to its full efficiency in moving the air. The more modern method of mechanical ventilation by forcing good air in is known as the "plenum" system and, since it is bringing in the good air, helps to eliminate unwanted draughts, since the air pressure is higher within the room than outside, while it is possible to distribute the fresh air to the workers with greater discrimination. If necessary, it can be heated, cleaned, or humidified as it passes in. As the air is directed to special parts of the room this involves the use of ducts which must be made to reduce air friction as much as possible as described above.

Lighting the Factory

The Factories Act, 1937, makes adequate lighting compulsory, and appointed a Committee to advise as to the standards of adequacy and suitability. From the practical standpoint, however, the importance of this matter cannot be overestimated, since both the quality and the quantity of production will suffer if the workers are working under badly lit conditions. Other mal-effects of poor lighting include the increase in the number of accidents to workers and the decided fall in their health, while the standard of general cleanliness and order in the works will tend to go down unless the lighting is adequate.

While a small amount of light may be necessary to allow workers to pass from one place to another in the works, yet the light required for performing the detailed operations involved in the work will largely depend on that work. Thus, the light must permit every detail required to be seen with ease, so that the colour and reflecting powers of the subject matter of the work will affect the solution of the question as will the size of the details handled. The light may be directed upon the work direct from the lamp with possibly a shade to screen the light from the worker's eyes, or it may be alternatively indirect, i.e. reflected from some surface, e.g. ceiling, so that it arrives on the work more diffused and even, and avoids shadows. Indirect lighting requires more power but certainly obviates glare, but if close detail is to be watched, direct lighting is better.

Natural lighting by windows or roof-lights is always the best,

providing the glare and heat of sunlight are avoided. This source must be made the best use of by clean windows and bright reflecting surfaces in the nature of light walls and ceilings, and by avoiding any large object or storage of materials near to the windows to obscure the light within the room.

When natural lighting fails, then artificial lighting must be adopted whether by gas or electricity. The former has the disadvantages of fumes, heat, fragility of mantles, flickering, open flame, etc., so that its use in industrial factories is now decreasing in favour of the electric filament lamp. Artificial lighting may be general, lighting the whole of the room and casting sufficient light on the benches for the work to be carried on, or the general lighting may be just sufficient to allow movements between the benches, the light for the actual work being supplemented by local lighting, i.e. a lamp placed about 2 ft. away from the worker so as to cast its light direct on to the work, yet shaded from the eyes of the worker to prevent glare.

The question of colour must be considered with the lighting as the incandescent gas mantle and the filament electric lamp both give a light containing more yellow than daylight, so that where colour work is being handled the special "daylight" bulbs which introduce a proportion of blue into the light ought to be used. Mercury vapour lamps are occasionally used in factories and give a light of a greenish shade with the result that workers often object to their use.

The selection of the most suitable lighting system, and the provision of the requisite illumination for any particular working conditions demand careful analysis and calculation. Such factors as type, height and spacing of the fittings; nature of work, absorption value of surroundings, and depreciation all must be considered. Research by illumination engineers has made the task easy for those concerned with the provision of factory lighting. Several useful pamphlets have been published by H.M. Stationery Office on the subject. One, entitled *Electric Illumination*, price 6d., is recommended to those who wish to pursue this subject.

CHAPTER XXXI

POWER AND THE MACHINE

THE first problem before the industrial administrator at the outset on the question of power is whether it will be better to install a plant to generate power for the factory, or whether it can be better bought outside, either in the form of electrical energy or otherwise. This is not entirely a matter of cost, though naturally expense will be a vital factor, and in comparison of costs it will be found that the charges of outside suppliers are usually based on a sliding scale, i.e. lower rates per unit as the amount consumed increases. There is also the question of the reliability of an outside source of supply, since a breakdown may mean the hold-up of production in the whole works. If, therefore, some distance separates the factory and the source of power it is not advisable to buy outside unless they both be in the same town and alternative generators exist, when their reliability may be fairly high. In calculating the cost of the power plant to be installed in the factory, the following expenses, *inter alia,* must be included: Coal, water, wages, rent, repairs, insurances, taxes, interest on capital, depreciation, removal of ashes, etc. These operating expenses must include not only those on the power plant but also on the accessory plants such as fuel storage, waste disposal and cooling towers. There must then be brought into account the cost of supply of steam for heating the factory if a plant is not installed, or for supplying any other process in the factory. The estimates of costs of the outside and inside sources can be compared only when all these factors have been evaluated to determine the best source.

Methods of Generating Power

The main systems of power generation in use to-day are steam, the internal combustion engine, and the electric motor. These take several forms, thus steam may be generated to drive either a reciprocating engine (i.e. one driven by the expansion of the steam in a cylinder pressing a piston along its stroke) or to drive a turbine, in which the steam is forced through a fine nozzle against the blades of a wheel, forcing it round. The internal combustion engine includes

crude and refined oil and gas-fueled engines. The use of water and air for power purposes does not comprise a very important source of power in this country though overseas it may be one of the main sources.

It is not the purpose of this book to go into great detail on the methods of these various machines, though an outline is necessary to the understanding of their relative advantages. In the steam plant the steam must be raised in boilers heated by either coal or oil. Cost in the district of the plant will be the first factor in deciding between these two alternative fuels for heating the boiler, though it will be noticed that oil is much cleaner than coal, can be more easily handled and stored, while the burners may be said to be almost automatic in their action, so reducing labour costs, though the recent developments in mechanical stokers for feeding coal to the furnace fires have also reduced labour costs for coal considerably. These automatic stokers may be of three different types: the overfeed system carries in fresh coal, delivering it on top of the fire, the underfeed system delivers the fresh coal under the surface of the fire so that the coal is forced to the surface as it burns, giving off its heat, while the last system consists of a chain grate where the fresh coal is poured on to the continuous grating as it enters, carrying it into the fire and passing out at the far end, drops the ashes as it turns over to return on the underside.

Boilers may be either of the cylindrical shell type, where the fire grates are contained in large steel tubes which pass through the outer shell and are surrounded by water, or they may be of the water-tube type, where the water is contained in a large number of small diameter tubes which are suspended inside the furnace chamber. The Cornish Boiler is the simplest type, being a cylindrical boiler often about 7 ft. diameter and 25 ft. long, stayed within to withstand the pressure, and a single fire flue built in as shown in Fig. 73. In the Lancashire type, two fire flues are provided slightly smaller than that in the Cornish and arranged side by side so that twice as much steam per hour can be obtained. These boilers are fairly cheap and work quite well for pressures not over 120 lb. per sq. in., though their efficiency (i.e. amount of energy output as compared with consumption of fuel) is usually low. To help their efficiency as well as to speed up the initial raising of steam, Galloway tubes are fitted to lead the water across the surface of

the fire (Fig. 73), though there is a great danger that these small tubes may be quickly coated with scale and be useless.

The Scotch marine type of shell boiler permits of higher pressures than do those shell types already described, and although primarily intended for marine work is also used for stationary power generating purposes. It is shorter but of much greater diameter than the

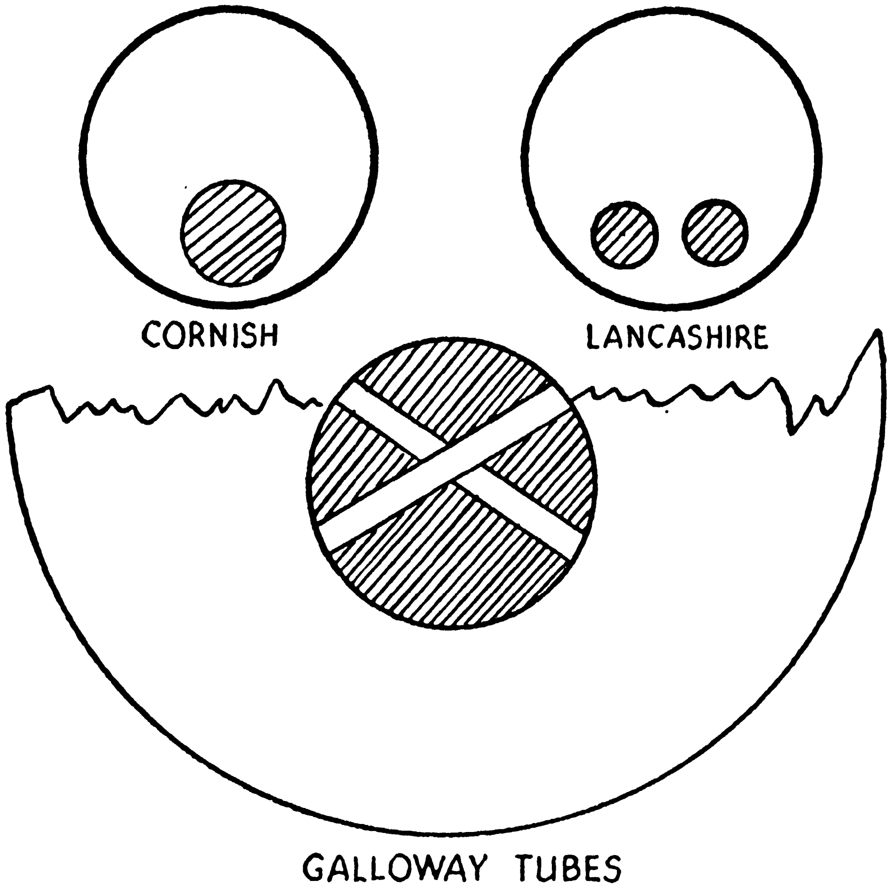


FIG. 73

Lancashire boiler and may have two or three fire flues. A large heating surface is obtained by the additional use of a combustion chamber and fire tubes. Each fire flue contains a fire grate and communicates with a combustion chamber. From the combustion chamber and situated above the fire flues, a series of small fire tubes communicates with the uptake. The hot gases from the fuel burning on the fire grates are drawn by chimney draught into the combustion chamber, through the fire tubes and into the uptake, and since all are surrounded by water, considerable heating surface exists.

In the water-tube type of steam boiler the boiler is not in direct contact with the fire, but there are tubes leading the water into the heat of the fire. These are inclined at about 30° to the horizontal so that the water rising as it is heated is kept in constant circulation,

while the thin tubes allow the water to boil very quickly. Since the tubes come into direct contact with the heat, less of the coal heat is wasted, the boiler takes up much less space, the greatest pressures are obtained, while amounts of steam up to 20,000 lb. per hour can be produced. The use of an external fire also allows fuel of a lower grade to be used than could be used in the tubular boiler.

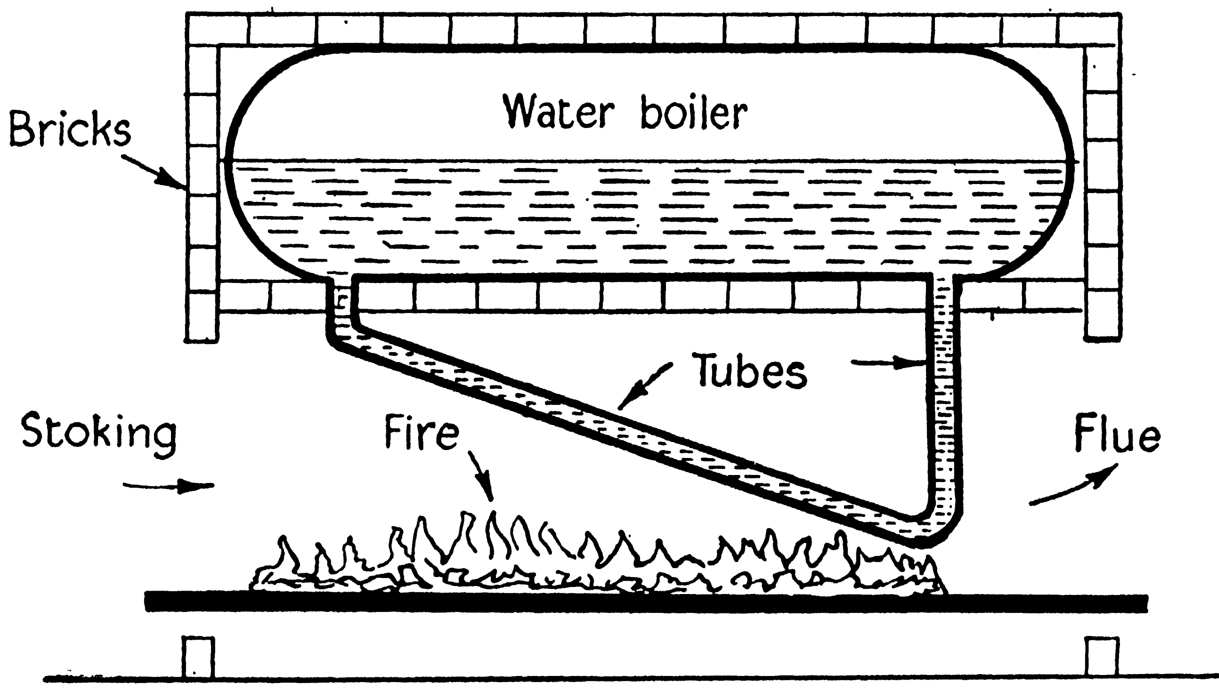


FIG. 74. DIAGRAM OF WATER TUBE BOILER

The difficulty of cleaning these boilers is fairly great as compared with the tubular, which can be entered by a man for scaling off the hard chemical deposits which accumulate from the water. These boilers also require closer attention for stoking, since if the fire is allowed to fall off slightly the effect is quickly felt.

To each of these boiler types a safety valve will be fitted to blow off the steam if the pressure should rise above the limit fixed, and a water level alarm which gives the alarm if the water level falls below a certain point. A water gauge and steam pressure gauge will be fitted at the front of the boiler.

There are several accessories necessary to a steam boiler for treating ingoing water or resultant steam. To reduce "sealing," i.e. the depositing during the boiling of chemicals such as lime suspended in the water, the water should first be passed through a filter and a water softening plant. It can next be heated either by passing it through pipes around which is led the exhaust steam from the engine or by an economizer where the pipes are led through the exhaust flue gases between the boiler and the chimney, so that

only warm water enters the boiler. It is forced into the boiler by an "injector," an apparatus whereby live steam projected through a nozzle into the water condenses to form a vacuum causing the water to be drawn in through a valve into the boiler (Fig. 75). When the steam leaves the boiler it may be led through pipes placed in the furnace flue so that it is "superheated" and its efficiency

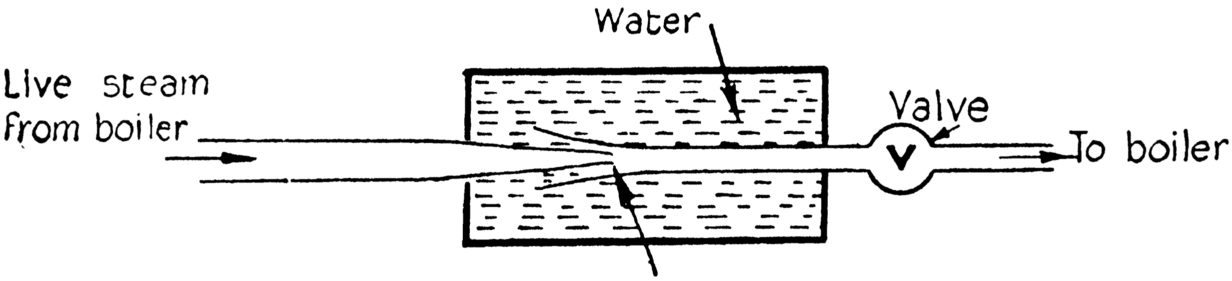


FIG. 75. DIAGRAM OF "INJECTOR"

increased. Thence it will be led to the engines and, as the power of the steam is wholly dependent on its heat, the pipes must be "lagged" or covered with non-heat-conducting material to prevent heat losses which may also be affected by the thickness of the pipe and the speed that the steam moves along it. The steam should also be dry, since any moisture will greatly aid the heat losses.

The principle of the reciprocating steam engine is probably well-known to the reader, but its relative inefficiency is not so generally known. In passing through the engine the steam only gives off about 15 per cent of its energy and the rest is lost in the exhaust. The compound with two cylinders, and the triple expansion with three cylinders were introduced to utilize this waste by passing the steam from cylinder No. 1 into a bigger low-pressure cylinder where it could still further expand and do work, and with three cylinders into yet another cylinder. The difficulty of the 15 lb. per sq. in. air pressure against the exhaust steam may be overcome by a condenser, which is an apparatus which leads the exhaust steam into water, so cooling it into a liquid immediately and causing a partial vacuum not offering any resistance to the outgoing steam.

Reciprocating engines may work at speeds from 100 r.p.m. to 600 r.p.m., the faster being heavier on steam and repairs but cheaper to buy and install. These speeds are most uneconomical where the machine is to drive electric generators, so that the turbine is then used, which is based on the principle of a wheel with many vanes

being impinged by jets of steam directed from nozzles under high pressure, causing the wheel to be forced round at a high speed. There is thus no to-and-fro motion and the axle of the turbine wheel can be coupled directly to that of the driven generator. If a condenser is used the steam consumption can be kept up to a very efficient level while for cost they compare very favourably with reciprocating engines, though they only occupy about 20 per cent of the floor space of this latter type of engine.

The internal combustion engine is of the reciprocating type and is worked by the expansion of gas within the cylinder. The gas may be supplied either directly as gas or in the form of liquid fuel. Gas engines employ either Town Gas, taken through meters from the public supply, or Producer Gas, which requires special plant. Oil engines use either refined oil, such as paraffin or petrol, or crude oil. When crude oil is used compression ignition is employed. This means that air only is drawn into the engine cylinder on the suction stroke, and this air is compressed to such a degree that the temperature produced by compression is sufficient to ignite the fuel injected into it without the aid of external ignition apparatus. The other forms of internal combustion engine draw in a mixed charge of vaporized oil and air, compress it to a state which is below self ignition point and then ignite the charge by means of an electric spark timeously supplied.

These types of engines are certainly very effective and need little attention, while the expense of the power house is reduced to a minimum with their very small size, and the question of disposal of any waste is entirely eliminated.

Electricity may be generated by the works power plant or may be purchased outside as discussed in the opening of this chapter, and then led to the motor to be converted into energy. Motors may be either alternating or direct current. The former type have the advantage of always running at one constant speed, while the motor itself is simpler, the commutator being unnecessary, and the direct current motor will be used where variable speed is required. The energy output for the current consumed will be found to be greater in the case of the direct current motor than in the alternating motor, so that the waste of power must be taken into account. Electricity is, however, rarely used to generate mechanical energy in a power house, but because of the ease of carrying, is taken by

wires direct to the point in the works where the drive is required and applied to an electric motor actually incorporated into the machine itself so that the drive may be positive and none lost in transmission, except possibly a small fall in the current due to the resistance of the wire leading the current into the works.

Power Transmission

The power having been generated, the next question is its transmission to the points where it is required to drive the machines. In the older factories the power from a single motor, located in the power house, by shafting, belts and gears was transferred to the machines in the shops with great frictional losses on the way. The next development was the group drive, with several motors each driving a department or a group of machines so that frictional losses with the shorter drives were reduced while it was possible to run one portion without the other motors also running. But the best is the individual drive mentioned above, where each machine has its own electric motor so that the losses are the lowest and the machines can be placed irrespective of their relation to shafting or drives, while the economy in only running a motor when actually wanted may be enormous, though the initial cost of installation of this method is much greater than any other method.

In considering mechanical methods of power transmission, the two chief difficulties are the reduction of friction to a minimum and the avoidance of undue strain on any part. Friction in the bearings may be reduced 90 per cent by the use of ball bearings, which, although rather expensive in their initial cost and installation will, if properly lubricated, outlive the shafting and almost eliminate wear. Shafting should be supported in easy-running bearings placed at distances apart not more than 30 times the diameter of the shafting itself. The pulleys will be fixed on to the shafting as near to the bearings as possible with "keys" (Fig. 76). If the pulleys are crowned, i.e. the surface made not flat but convex to a slight degree, it will prevent the belt running off the pulley. To prevent undue belt slip, the ratio between the diameters of the two pulleys, the driver and the driven, must not exceed 6 to 1 otherwise the belt will not grip the smaller pulley sufficiently.

The strength of belting required may be determined by the power it has to transmit to drive the machine. It is generally considered

that leather belting $\frac{3}{16}$ in. thick will transmit 1 h.p. for each inch of its width when running at 800 ft. per min., or a double belt $1\frac{1}{2}$ h.p. Leather belts require constant attention, washing and oiling, and if regularly adjusted have a very long life. In the case of belting exposed to moisture of rain or steam, rubber belting may be used. Belting should be arranged so that the drive of the pulley puts the slack side on top so that the natural sag may aid the belt in wrapping round the two pulleys rather than sagging away.

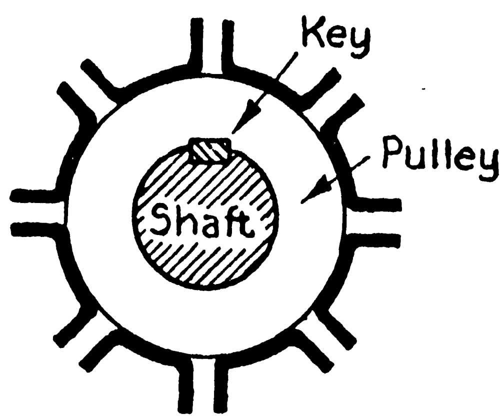


FIG. 76. KEY FIXING PULLEY TO THE SHAFT

Ropes are occasionally used when the distance between the two pulleys is at all great or unusually short, and while the cost of the ropes is much lower than the cost of leather belting, the cost of the grooved pulleys necessary for ropes more than offsets any gain in this direction. The great pliability, strength, and low rate of stretch make them peculiarly suitable for drives round corners and providing they are kept dry they need very little attention.

Gearing may be used for power transmission and has the advantage of a positive drive for those operations where the relative speeds of the driving and driven shafts must remain constant, since there is no slip such as occurs in belt drives. Gearing can be used for angled drives and can be designed to transmit either light or heavy loads in smaller space than by any other mechanical means. Chain drives also provide a positive relationship between driving and driven shafts and are usefully employed as are gears also, in many machine tool drives. They are useful for spanning shaft distances which are too great for the convenient employment of gears. If properly installed, shielded from grit, and amply lubricated, preferably in an oil bath, both gears and chains are efficient and extremely reliable.

Mention must be made of the pneumatic system of transmitting power by compressing it to high pressure in the central power station and leading it through pipes to motors in the works. It is certainly cheap and easy to transmit or store, but from an engineering point of view its efficiency is not very high. Its use for hand tools, however, has been found very successful because of the ease of transmission,

but in practice the losses due to leakages, which are not easily detected, are usually enormous.

Lay-out of Machines

The whole object of studying the question of the lay-out of the machines within the factory is to expedite production by reducing internal transport from one operation to the next as much as possible.

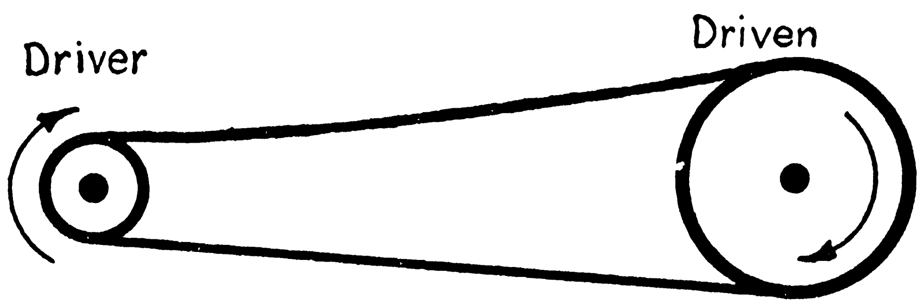


FIG. 77. SLACK SIDE OF A BELT TO BE UPPERMOST

Thus, those machines must be placed next to each other which perform successive functions on the same piece of work so that the work may flow easily and speedily from one machine to the next with perfect continuity of operation from raw material to finished product.

This means that the lay-out of the works will depend entirely

Raw Materials (malt) → Malt Store
↓
Weighing Room
↓
Screening Room (cleaning the malt)
↓
Grinding the malt
↓
Mash Tun (i.e. the ground malt is mixed with water, allowed to stand, and then the water run off)
↓
Raw Materials (hops) → Boiling in coppers

Cooling
↓
Raw Materials (yeast) → Fermenting squares → yeast collected
↓
Beer run off to Racking squares
↓ Bottled
↓ Barrelled

FIG. 78. DIAGRAM OF FLOW OF WORK IN BREWERY

on the nature of the product of the particular works and other special circumstances. The first thing, then, must be to study the successive operations of the particular industry and to arrange them in a proper sequence. In the case of those industries producing one single product in a continuous stream, the raw material being constantly introduced at one end and the finished product issuing at the other, it is an obvious matter. Thus, in the case of a gas plant or brewery there will be little difficulty in arranging the plant, since it will follow the natural flow of the processes. This will be clearly seen in the diagram on page 234 of the processes in brewing beer.

Where, however, there are introduced two parts of the finished article which go through several processes separately before being ready to be joined, after which they are still further operated upon, the flow sheet may be modified. Thus, in manufacturing boots and shoes the following diagram illustrates roughly what takes place—

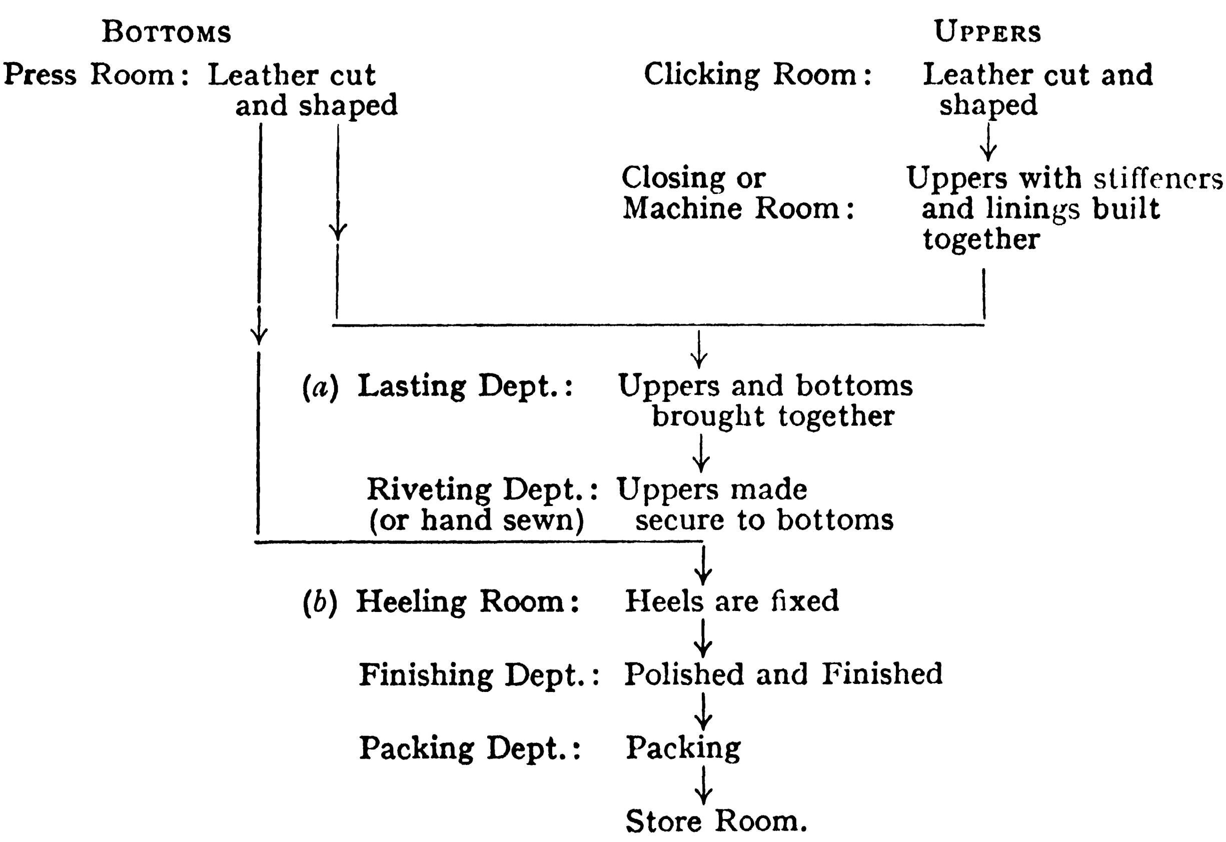


FIG. 79. MANUFACTURE OF BOOTS AND SHOES

It will be noticed here that the uppers, soles, and heels are each made separately and brought together or assembled at points (*a*) and (*b*), so that the lines of production in the factory must be arranged that the units are available at the required point. In

every industry this movement of the work must first be studied if the plant is to be properly laid out.

The next stage in the problem will be to ascertain the exact number and kind of machines necessary to produce the quantity of the product which the sales department considers it can sell. If the product takes many diverse forms, then each must be examined and the results combined having regard to the time which each one will occupy each separate machine. That is, a paper calculation of the machines necessary to handle the total production must be drawn up, having regard to such factors as the time involved in moving the material and product before the next operation is begun.

Where production is continuous, this involves the balancing of the equipment. Thus, if machine No. 1 can perform its operation on 1000 articles per hr. but machine No. 2 works only at a speed of 600 per hr., it is obvious that two machines No. 2 must be obtained or a "bottle neck" in production will arise, unless a reservoir is to be provided to store the excess for a time until No. 2 by overtime or by stopping No. 1 can catch up.

The machines required having been decided, they must be arranged in the best order. If the work is continuous and passes naturally from machine to machine, they will follow the production order, not necessarily in a straight line but so that each machine is adjacent to the next in the chain of operations. If, however, the work handled by the machines is varied so that no straight line can be arranged, then the machines should be grouped according to their nature, thus milling machines together, lathes together, planers in another group, etc., so that the supervision by the foreman skilled in each of these groups may be simplified. This arrangement can be done best in practice by preparing a plan of the room to scale and by inserting the machines, also to scale, and marking the flow of the work in red ink. Any bad arrangements should then be quickly revealed. In laying out the room, ample space must be left for the operators to each machine and for the stacking of work to be done and finished at each machine, as well as gangways where two trucks will be able to pass without difficulty. If the work results in any waste, then receptacles must be included in the plan for these. For internal transport, conveyors may be installed so that these should be shown and will often decide the situation of certain machines.

It is not sufficient just to locate the machine in a certain spot, but it must also be arranged that it is facing the best way for work to flow into it from the left and out on the operator's right or *vice versa*. The shafting may affect its arrangement to prevent any twisting of belts or countershafts, while the lighting may determine that certain processes must be moved near to the windows where they can have the needed benefit of the best light.

In the earlier part of this book the importance of inspection has been shown, and this department must be incorporated into the plan. If the inspector is a wandering inspector, checking the work in the machine, it will not affect the lay-out, but if the finished article is to go through his hands before leaving, then his bench or desk must be allowed for in the correct spot. Tool stores will also receive similar treatment.

Not only within the department but also the departments themselves must be suitably arranged. Thus, the Goods Inwards and Goods Outwards Departments must be situated near the road, railway, or canal through which the goods are conveyed. Adjacent to these departments will be the store-rooms of raw materials and of finished goods respectively, with their assistant inspection department. The power house will be situated where its raw materials can be delivered expeditiously as well as its waste products taken away. As the power is to be delivered to the main manufacturing department the power house will be situated near to this latter department which, being the key department of the whole works, will occupy the central position. Within the production part of the works the departments will be arranged entirely with a view to speeding up the flow of the work, with the exception that if any departments by reason of fumes, noise, heat, etc., are obnoxious, then the nuisance should be separated as much as possible from the other workers in the remaining departments. Similarly, if very heavy or vibratory machine is necessary, it is wisest to install it on the ground floor because of the strain on the building and the possibility of the use of cranes, etc., for the handling of the heavy products. The tool-rooms, toilet-rooms, and other necessary assistant departments will naturally be placed nearest to the point where they will be most required.

The main object of scientific lay-out is seen to be the elimination of waste effort and the speeding up of production.

Maintenance of Machinery and Plant

When the machinery and plant has been installed and production begins, then begins also the wear and tear on those assets, and it is to maintain the working efficiency of the plant at its highest level that maintenance services are retained. Their work includes more than simply doing repairs, but also by constant inspection and service to prevent as far as possible any breakdowns occurring resulting in interference in production. This means the constant examination of all machines for signs of wear, damage, or other indications of impending breakdown, and when such are found to rectify them. The study of breakdowns and repairs by this department may also lead them to make suggestions to the management for the modification of the use or design of the machines to reduce future trouble.

Whether this maintenance function will be performed by a separate and distinct department or whether it will be part of the duties of the works engineers or shop superintendents, etc., will depend largely on the size of the factory and their ability to maintain such a specialized department.

The routine work of the maintenance department requires careful planning. It is imperative that such work as the lubrication of main transmission line and countershaft bearings be attended to as a scheduled duty; otherwise neglect is inevitable. When it is remembered that a "seized" main transmission line bearing can hold up the production output of a whole machine battery or section, the importance of this aspect of maintenance will be appreciated.

Periodical survey of all machines and plant should not be haphazard; a plan of inspection is essential. A completely organized maintenance department will have an indexed record of every item of plant in the factory divided into classes such as tools, electrical apparatus, machines, etc. Each of these records will indicate the times when the item should be and is inspected: thus belting may specify inspection after the first and second day, then at the end of the month and subsequently every two months; windows to be inspected every September; fire pails to be checked every week, etc. A "tickler" or card-indexed diary system should also be adopted to arrange that the card record of each item of plant will come up for attention at the next date when it is due for its periodical attention so as to ensure that no item is overlooked.

In conjunction with this, individual instruction cards should be issued to the workman concerned with the survey and these cards should have spaces for the date of completion and the survey report. Apart from their obvious usefulness these records will provide evidence if required in connection with Workmen's Compensation cases or with visits of H.M. Factory Inspectors.

One of the great dangers is that this inspection may become a mere farce, since it is not possible directly to measure the amount of work done, and it may be done in a casual ineffective manner like the railway worker who tapped the wheels of railway coaches for 30 years without knowing why he did it. It must, therefore, be performed by men who understand fully the machines they are inspecting and who are given report cards to be completed, detailing each point to be inspected and requiring a tick as they do each item.

Dirt is the first item that maintenance must eliminate, and this includes waste, scrap metal, etc., which unless quickly cleared away will cause wear and tear on the machine. This detailed cleaning will probably lead to the detection of any loose parts which may require tightening. At the same time, the lubrication of the machine will be checked so that excessive wear is not taking place at any point. If any part is found requiring repair, then this must be discussed with the departmental manager so that the best time for doing it can be chosen, when the putting of that machine out of action for the length of time necessary to do the repair will inconvenience production the least.

In many machines as a safeguard against breakdown causing serious damage, there is often included in the design what can be called a mechanical fuse. It is some part of small importance which is of less strength than the uniform strength of all the other parts individually, so that if, by overloading or jamming, a stress is placed on the machine, instead of any vital part breaking, the weaker member, which can be simply replaced or repaired, gives way. If this were not done, the jam might have caused considerable damage when a breaking stress is put on the many component parts of a machine; as it is the stress is broken much below the breaking point of the other members.

CHAPTER XXXII

MATERIALS ORGANIZATION

THE work of the stores organization in the factory is to receive and examine all incoming goods, to keep them in the store-room under proper conditions so that they may be available when required, and to issue them when properly authorized requisitions have been submitted. The methods of examining goods on arrival and the issue of those goods against requisitions have already been described in Chapters XXVI and XXVII. The principles of storekeeping will be described here.

The actual situation of the stores will depend on the nature of the work in the factory, for the materials must be conveniently to hand for those departments which will require supplies from the store-room, so that the minimum of delay may arise. This will apply much more forcibly if the goods are heavy or bulky, so that they require special equipment for handling, since it is much better to let any delay which may arise in handling occur when the goods are being brought *into* the stores, than when they are being taken from the stores into production, lest production be held up. In some cases the stores are better decentralized, i.e. a separate store-room for each department and not one for the whole works. This will arise when certain materials are required by only one department. Yet this means a heavier expense of labour involved in several stores as compared with one concentrated store-room for the whole factory. The actual space occupied by these several small departments may prove costly, for space in the midst of a productive department is valuable, so that the stores kept there should be reduced to the minimum of those actually in frequent demand.

The nature of the materials to be stored will have a deciding influence on the form that the stores-room and organization will take. Thus raw materials of the nature of sand, iron ore, timber, etc., can be stored out of doors, since it will not be affected by the weather, a mere roof above it being sufficient. But if the material is liable to be affected by damp (such as cement or iron castings) then a dry store room must be provided, while if the material is delicate

and of such a nature that it might be easily soiled, it will be stored in closed containers.

Stores Lay-out and Organization

The location of the stores-room and the space to be allocated to it having been decided, the storage arrangements must be so planned within the room as to give the most effective use of that space. This means that any item in the stores can be obtained without difficulty or delay. The floor should be marked out with aisles between the rows of stacked materials or bins, and each separate location for

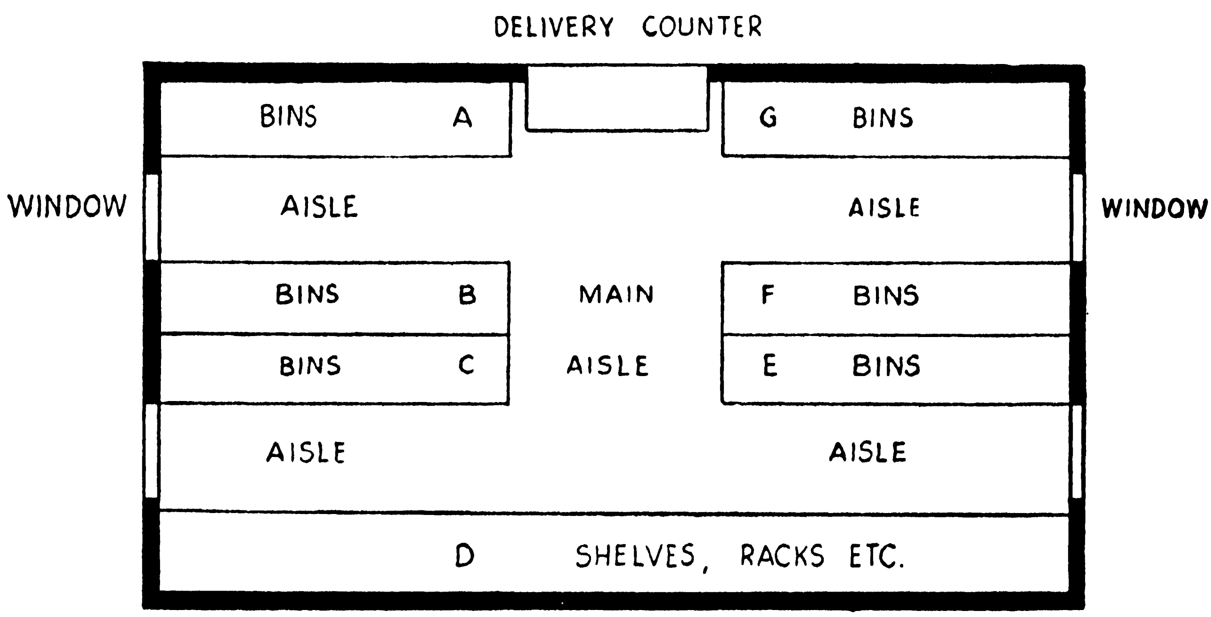


FIG. 80. LAY-OUT OF STORE-ROOM

material in the store-room identified with a letter or number, so that any bin or rack can be exactly identified as, for example, aisle D, bin No. 18.

These aisles should be arranged crosswise rather than lengthwise, so as to cross the line of greatest traffic to prevent confusion and afford uninterrupted access to each bin. A main wide aisle can be provided down the centre of the room so that the actual aisles beside the stored materials are short, which means that when a storekeeper is busy obtaining materials from a bin or otherwise handling any material, the likelihood of others passing him is reduced. Short aisles branching off from a main centre aisle mean also more speedy finding of goods, as well as the more effective utilization of the window lighting, which would be cut off by long, lengthwise rows from the centre of the room. Finally, the fire aspect may

be noticed, since the ease of getting to any local outbreak is increased. A typical lay-out on these lines would be as shown on the previous page.

It will be noticed in the above lay-out that all the rows of stored materials run parallel, that the lighting has been left free while the aisles are not too narrow to prevent easy handling. The width of the aisles will largely be governed by the bulk of the goods being handled, and the trucks or conveyers which may be used for carrying the goods. The main aisle must be wide enough for passing of two trucks or two persons, but this is unnecessary in the side aisles which are not to be regarded as parking places for idle trucks. It will invariably be found that if the storage room is to be used to the full advantage, materials must be stored on both sides of every aisle; to leave a blank wall beside an aisle is to overlook an obvious natural support for bins and shelves.

The store-room having been planned, the floor should be marked with white lines showing the storage spaces as well as the location references, so that it may be definite and permanent. If the whole of the stores are kept in bins, this may not be as necessary as if the goods are to be stacked or dumped on the floor. The references can often be made to indicate their situation by giving the floor number or the department letter coded in the reference. Each bin, rack or other material container should have a metal holder affixed into which can be inserted a card bearing the exact number of the bin for identification. Thus, bin No. 52 in row E in the stores in the machine shop may be coded as MS/E64.

Spaces must also be provided in the store-room for handling goods on receipt, for unpacking, examining, and the temporary storage until they can be put away into their proper places. In a similar fashion a space may be allocated for assembling items out of stock for any particular order, as when a materials specification is received for a particular job and the materials for that job are taken off the shelves ready to be handed over.

There must be no confusion in the store-room about the naming of each item of stock, so that it is wise to arrange for careful identification by having every item labelled with a clear and complete description. This means a careful classification which is best done by a card index coding the full description to a code number which can be stamped on the article itself, the number preventing any

confusion with any other item. When placing goods into store it is wise to store them so that this number is conspicuous to act as a check on misplacement.

The place to be allocated to each item in the store-room will depend on the ease of handling, so that those more difficult are placed where the handling in getting out of the stores will be the least; this means near the main aisle or door. For similar reasons, if certain goods are often wanted in large quantities, the size of the usual requisition may affect the location. Those items which are most often demanded should have a preferred place to those more rarely required. There may be some special features—such as the length of steel bars or the perishable nature of the goods—which, by reason of the special equipment necessary for storing, will determine their exact location. At the same time it is generally advisable to keep together items of a similar nature. The goods may be heavy and the nature of the building may make it necessary to watch the stresses on the floor in arranging the stores, while the fire liability may also make wider and more frequent aisles desirable.

As the goods are stored away they must be so arranged that they can be obtained with ease when required and in the desired quantities, so that no items will be permitted to obscure any other group. It is advisable to arrange the goods so that the greatest number are showing to facilitate stock-taking and prevent mistakes. If they are arranged in an orderly and regular fashion, such as rows of ten each, the counting is made considerably easier. The space given to each item must be more than enough, so that there can never arise the possibility of a bin being full up and the excess being stored elsewhere, forgotten, and more ordered before the whole of the first are used. No bins or racks should be fixed to the floor, but should be left so that any changes later found necessary in the arrangement of the stores can be made without difficulty.

As we have seen that every item of stores has its delegated place, there is no excuse for the storage of goods on the floors or on window ledges, etc. The heavy bulky materials, such as barrels, bags, crates, which may be awkward to lift, may be stored in rows on the floor, but all other bins to hold the small stores and the racks to hold the long stores are mounted on platforms, to keep them away from the dust and dirt of the floor. They should not be piled or

tiered higher than can be conveniently reached, i.e. not more than approximately 5 ft. 6 in. from the floor, unless mechanical aids are used for handling. Stacking of items should be done by starting in the back left corner and piling upwards till one pile is completed, then the next pile in front of it till the whole of the left side of the bin or space is covered, when the next pile will commence again at the back left and work forward. This systematic method means that it is always possible to know which batch first came into store, so that when taking out it may be used the first.

The internal arrangements of the store-room have been completely

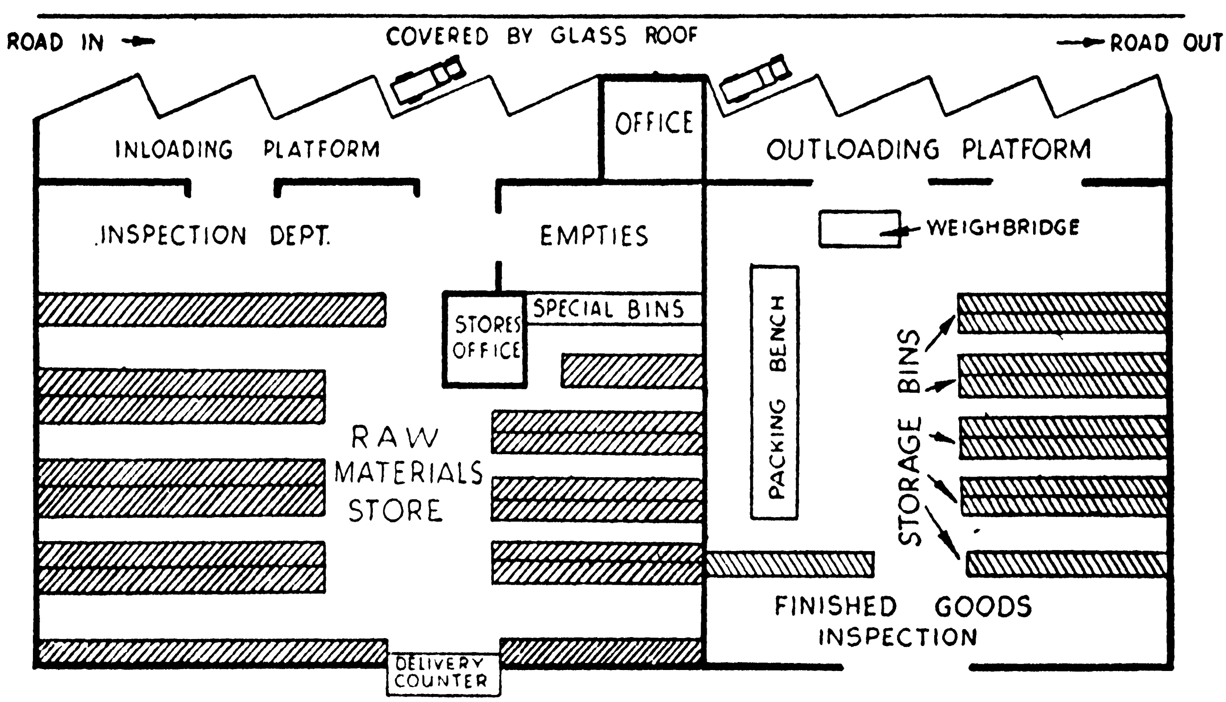


FIG. 81. COMPLETE STORES LAY-OUT

described above, and it now remains to consider the wider relations of this department. When goods are received they pass through four stages before going into production, viz. (*a*) receipt, (*b*) inspection, (*c*) storage, (*d*) issue from stores, so that the lay-out of these four sections must be suitably arranged for a natural flow of the material from receipt to issue into the factory.

The receipt department will be arranged according to whether goods are being received and unloaded from a railway siding, from road vehicles or from barges, but in every case a platform should be run out so that goods can be unloaded expeditiously. If they are being taken from lorry or truck the floor should be raised to the level of the truck floor, so that the goods can be wheeled or rolled directly off the truck into the department for inspection.

All goods received must be promptly examined, so that only goods suitable for production are passed into the stores. This means testing for quality as well as quantity, and giving a report to the office on every batch received for checking with the order and invoice. From inspection the goods will pass into the stores and so to the works.

These principles are well illustrated in the complete lay-out shown in Fig. 81. It will be seen that a road provides the source of materials, so that a loading platform has been built alongside a private covered-in road. This platform has been built with the sawtooth edge to allow unloading from both the side and the end of the lorry at once. Overlooking this platform is a small office, where the carters' records and other clerical work and control over the actual dispatch can be conducted. The goods pass immediately into Inspection Department, where they are unpacked, examined and tested. The empty packing cases and other "returnable empties" are passed into a special room kept for this purpose, so that the Stores are not lumbered with these non-productive elements while they are still kept in hand for recovery of the charge. From inspection the goods pass into the raw materials stores, passing on entry the storekeeper's office where the clerical records of the stores are kept. Incidentally, just behind this office may be noticed a row of special bins where certain valuable items of stock, or items which for some other reason require special watching, are kept under the windows and gaze of the stores office itself, an additional check over these special items. The goods then are requisitioned from stock and handed into the works over the delivery counter.

Besides this store-room is found the store-room for finished goods through which the output of the works passes to the customer. Coming from the works through an Inspection Department it is entered into the stores and stacked on the bins or racks until required. The customers' orders are made up on the benches from the bins, and passing over a weighbridge go out to the loading platform, where the lorries emptied of their inward load at the first platform are now available for collecting the load on the outward platform. This lay-out, as should any other which may be adopted, permits a direct flow of the material without any crossing or other possible sources of interruption.

Simplification

By simplification in an industry is understood the elimination of all uses of materials and labour which are not entirely essential, so that time and capital can be concentrated on the more effective elements of production. There is in most businesses often a great variety of sizes, types and styles of a product of which only a proportion have any appreciable turnover, but the slow-moving items are retained to meet the demands of the rare customer who may require such special types. But the expenses of rent, depreciation, interest on capital locked up, etc., on these items often far outweigh any possible profit on their ultimate sale, so that it is advisable to eliminate them entirely and to concentrate on the quick sellers.

This reduction of the number of styles or sizes, and the elimination of the unnecessary varieties, will result in there being much less capital tied up in stocks of raw materials as well of the finished lines, and of jigs, dies and other special tools for the unnecessary lines. This means a reduction also in space occupied by stocks, and a concentration of production on a less number of lines, so that equipment can be more specialized and used to a greater extent. The repetitive nature of the work with the reduction in lines made will also react on the labour costs with the increasing skill. These factors are going to make reduced production costs as well as to speedier deliveries, so that the consumer will gain in prices and in service.

The whole object is to cut out wasteful lines and to concentrate on those for which there is the greatest demand.

Standardization

These developments towards the simplification of manufacture by specializing or concentrating on certain better lines have led to the natural development of the adoption of standard lines, standard parts and standard methods, the standard being in every case the best possible, so that the unsuitable is excluded. This system of standardization or interchangeability of parts is well exemplified in the memoirs of Simeon North who, in 1813, entered into a contract with the U.S.A. Government for 20,000 pistols, in which contract there was a clause: "The component parts of pistols are to correspond so exactly that any limb or part of one pistol may be fitted

to any other pistol of the 20,000." It means, therefore, that in making the product each one shall be exactly alike, i.e. that each one shall accord exactly to the standard set, and variations are not allowed unless proved necessary. This does not mean that once a standard is set up it shall never be altered, but remain constant for the whole future. A standard is simply the best that can be evolved at that time, and when improvements are made then the standard must be altered to incorporate the changes.

This principle of interchangeability not only reduces the cost of manufacture, since labour and capital costs are lowered, but also helps the buyer since repairs can be so much more quickly effected by replacing the defective part with a new one from stock which is a perfect fit not requiring any adjustment. It is necessary, of course, that all the parts shall be made to a sufficient degree of accuracy to permit this interchangeability. One of the earliest examples was the result of the work of Sir Joseph Whitworth, who started in 1841 the move towards the standardization of screw threads. All screw threads are now within three standards. One is that evolved by Whitworth, and another is that known as British Standard Fine Threads introduced when the high-tensile steels were invented. The Whitworth screw thread was also found unsuitable for screws of less than a quarter of an inch diameter, so that a third standard, known as the British Association Small Screw Gauge, was set up. Another example of the standards introduced into an industry was the standards adopted for rolled sections. As a final example it might be mentioned that forty years ago electric light bulbs were made in over one hundred different sizes of holder and socket. The present standard of one enables any lamp to fit every holder.

It will be noticed that in these cases the standardization has been adopted, not just by one manufacturer for his own products, but by the various firms within an industry. This means proper co-operation, and is usually effected through the association of the members in the industry. The standard may be evolved by a process of elimination, i.e. leaving out those elements considered unnecessary, making those which remain the standard. This is the method commonly adopted. The alternative method is to discard all the usual sizes and to develop new standards on the basis of some information as to what is the best. In the second case the new are

usually introduced and, if they prove successful, the old are gradually dropped.

Standardization may take several forms, being in the first place merely standards of definitions or of symbols to describe matters in the works such as the code numbers for component parts, etc. Another common form is the standardization of sizes and shapes of articles. This may be a design which is considered to be the best, or the strongest or the most suitable design. When buying goods a certain standard may be laid down as to the quality which will be demanded, or in the case of entering into contracts a specification may be given laying down the standard of workmanship which will be demanded. A common form of standardization is that which gives the ratings of a machine, etc., such as a machine of x horse-power, or a lamp of y watts.

There will be considerable benefits to the works from any standardization by the reduction in the number of "set-up's" required for the machines which will have longer runs as well as needing fewer jigs, tools or dies; indeed, it may be possible to evolve and use a machine wholly specialized on the mechanical production of one specialized part. Purchase and Stores Departments are going to gain with the reduction in the diversity of lines in almost every aspect of their work. Sales Department should find their work also simplified, as the number of lines are concentrated on the best, while the reduction in price should cause sales to go up. The advertising also will concentrate now on the reiteration of the fine points of a few lines with the result that its effectiveness will be increased. The buyer will find that the service he receives when breakdown occurs increased while his price is lowered, so that it would appear to benefit everybody. Yet, on the other hand, specialization tends to make the worker more of a machine tender than ever, and may cause monotony of work though it usually also results in a reduction of hours. It will be noticed that specialization in a few lines means all the manufacturer's "eggs in one basket," so that it may be advisable to point out that this is wise only where the market in the product is regarded as absolutely stable. If capital is sunk into a specialized factory, that factory is entirely dependent upon its speciality which, if it should cease to be required will find upon its hands machinery and plant which, because of their specialized nature, cannot easily be sold. Specialization is

wise, therefore, only in those industries where demand is not likely to fluctuate.

There is a belief commonly held that standardization results in an inferior article to that produced by the skilled worker—a belief largely due to the cheapening of the price of the article, and partly to the belief that the fit of parts produced within limits to accord to a standard cannot be as perfect a fit as those made to fit individually. Under modern conditions of production this is not necessarily so, since, by modern micrometer measurement methods, there is put into the hands of the designer, the machinist and the inspector, the power to see that the limits set up by the designer (who has much greater skill and knowledge than the worker who is making parts individually) on the highly detailed drawings that are in use for quantity production, are accurately incorporated into every part. The variations in skill and the rule-of-thumb methods of the artisan are so avoided.

In these methods there are limits of accuracy or tolerances (see page 252) set up within which the work must accord, and in certain works where a very high standard of work is demanded, a system of selective assembly is adopted. Under this method the parts are made under the usual specialized methods, but instead of being assembled at random from stock they are selected and grouped by finer differences of dimensions into what amounts to a subdivision of the tolerance. By this means it is possible to produce under these methods work which is, as regards fit, more nearly ideal for the function it is to perform, at little more than the ordinary standardized production costs. The industries adopting selective assembly to-day will cease to require it with improvements and increased accuracy, i.e. when diminished tolerance in the parts can be adopted in routine manufacture. One feature of this selective assembly method is the restriction placed by the manufacturer as to the making of repairs other than in his own works, so that to maintain the reputation of the product resort is had to further selective assembly when making repairs to ensure a closer fit with the worn parts.

Mass-production

The principle of standardization outlined above has led to its adoption by many firms who are manufacturing in large quantities

by repetitive engineering processes complex machine products in factories specially planned and organized with this end in view. These factories have been described as operating on "mass-production" principles, while it is also sometimes referred to as the "American" system of manufacture, as it was first developed to any large degree in that country. These methods first began to evolve when watches, bicycles, sewing machines, etc., began to be produced in large quantities to meet the ever-widening market, when the volume of sales permitted these specialized methods to be adopted, assembling from a number of standard parts the finished product rather than making each one separately and independently. This is sometimes described as "fitting" being replaced by "assembling," and hand work by machine work, the old skilled fitter now being engaged largely on the manufacture of special tools for the machine rather than on parts of the finished product.

The best known example of these methods is in the motor industry following on the lines so well developed by Henry Ford who, by the intensive production of cars on mass-production lines, was able so to reduce their price that immediately he found demand satisfied at one price was able to reduce and so tap a further ever-widening market and keep his profits constantly rising. Yet this, of course, could be done only by still further specialization to reduce costs; for example, by the introduction of highly specialized machines perfectly designed for performing one single job, but by reason of their inflexibility incapable of being adopted to any other purpose. Hence, so long as this particular operation had to be performed the machine was a wise investment of capital, but that meant standardization of design and output over probably too long a period, for it must be remembered that a standard is only the best at any one time. When the product, therefore, had to be redesigned to meet new developments and changing conditions, it meant redesigning the plant with the old machine now useless. In such a highly specialized plant this must necessarily be on an enormous and expensive scale, simply due to the extensive use of such one-purpose machines in the production of articles which are subject (and what products are not?) to progress and development. This expense factor is one which must be taken into account when considering all the obvious benefits of mass-production.

In practice it will be found that changes in the product will be

constantly demanded, not of the whole product but of one or other components by reason of changing fashions, or to overcoming proved difficulties in use. To change any elements in the product means new jigs, drawings, tools, gauges, etc., all of which must be studied in relation to the existing components, so that the new can be introduced into the flow of work with the minimum of trouble, expense and delay, i.e. the change must be made as early as possible while production must not be hampered at all. These are two opposing factors, the first being the desire to improve the product as soon as possible, the second being the desire to hold back from any interference with present output for as long as possible. The existing chain of production and assembly is so finely developed that changes may be difficult, as well as costly, for new producing machines must be designed as well as the whole section of the works reorganized to bring in the new element. This causes constant opposition in the Planning Department and other sections of the works of a mass-production factory to any changes, so that there is a tendency to stagnation in detail improvement and in design of the whole.

Perhaps one of the most striking features upon which a person new to mass-production factories remarks on first visiting such an organization, is the intensive use of conveyors to bring the raw materials, the partly finished products, the components and the sub-assemblies successively and continuously to the operatives, who (as described in Chapter XXXI) are arranged in lines. Each man performs only one or two simple operations on the component, then replacing it on the belt to pass to the next operation, so that no man loses any time seeking the work or passing it on, but can get on with the actual operation of his job. Similarly, there is an economy in the handling of tools, since each man has work to do involving the use of only one tool, possibly of a very specialized nature permitting more rapid manipulation, so that he has not to lay down or to select suitable tools, but again can perform his operation with the minimum of delay. This has been described by one writer as "machine-fed team-work," though "chain-work" is the more common term.

The assembly of the product is also embodied on the conveyor principle, the frame or foundation of the product being placed on a large slowly-moving belt, so that in turn it passes before the different

operatives who each do their little specialized job or add their particular unit, so that the end of the belt sees the product completely finished. On the introduction of these belt methods, and the allocation of the different successive operations to the various operatives, a very exact study must be made of the time required for each operation, so that in order to get the maximum economy in labour costs and to prevent any hitch arising at any point, each man must have exactly that amount of work to do that his particular job may be just finished as the unit passes out of his reach and the next one comes into it.

Batch Production

Many firms successfully engage on the production of standard products which cannot be reasonably mass-produced. The products are of such a nature that continuous production over long periods is not justified, but at the same time it is possible to gain considerable advantage by some measure of quantity production. In such cases it is common to specialize in a particular product, to standardize certain types of that product, and to produce these in reasonable batches on plant that is adaptable to change. The heavier types of commercial vehicle, and stationary engines of moderate power are among this class of product. Workers are required to be more skilful in this type of production, as the extreme degree of "tooling up" common to mass-production is not warranted.

Unit Production

This form of production is concerned with the contract type of product, usually of a specialized kind. For example, large electrical generators and steam boilers are produced in this manner. The labour force in this case must possess considerable skill as exact repetition of processes seldom exists.

Accuracy of Work or Tolerances

It will have been appreciated that with the system described under mass-production, where the various parts are machined to certain standard sizes so that they will all fit at the final assembly of the parts, each item made must accord with that standard. But it is impossible without considerable expense in machining to avoid slight variations from the standard, so that it is usual to specify

"limits" of accuracy, e.g. a bar may be required to be ·5 in. diameter with limits of ± ·01 in., so that if the bar produced is anywhere between ·49 in. and ·51 in. it will be accepted as sufficiently accurate. These limits may be provided to allow for different qualities of fit, e.g. tight fit, running fit, etc., or may be for simplification in the machining process, or may be specified so that there will be a

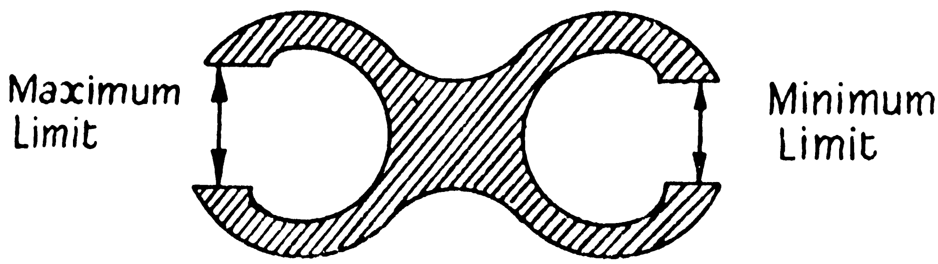


FIG. 82. LIMIT GAUGE

proper clearance between two parts as between two surfaces of a screw and a nut.

The determination of these limits will be done by the Design Department in co-operation with the engineer. They will be determined by the engineer according to the degree of difficulty in manufacturing to any limit of accuracy, bearing in mind the effect of wear on the tools or any other expensive manufacturing equipment, as well as an increase in manufacturing cost without any appreciable commercial advantage, and by the designer according to the cumulative effect on the allowance made on any other parts which have to mate with the part in question, e.g. a bearing may have a diameter of ·605 in. and the spindle a diameter of ·603 in. allowing ·002 in. clearance, but if a limit of accuracy of ·001 in. is allowed on each, a ·604 in. bearing will not give any clearance with a ·604 in. spindle. The limits will also be apportioned according to the wearing power of the various parts, favouring those that will wear most rapidly to ensure uniform and even wear in use.

These limits will be given on the machining instructions and on the plans prepared by the draughtsmen for the use of those concerned with production, as well as the inspectors who have the basis on which to accept or reject finished parts. These limits are often then made the subject of gauges (see Fig. 82), showing the limits within which the work must be machined, i.e. the work must not pass through the minimum limit while not being too big to pass through the maximum limit, or as they are called in the shops "go and not go."

Under mass-production methods a great deal depends on these tolerances, and the gauges themselves must be constantly inspected to keep them finely accurate lest wear and tear may make them inaccurate and the product be affected. Inspection under mass-production must be extremely rigorous, for it will be remembered that upon the adoption of suitable tolerances, and the verification of their maintenance, will depend the entire standing of the resultant product.

Definitions

The following definitions may prove helpful to the uninitiated—

An allowance is an amount of clearance or of interference between mating parts determined with respect to the correct functioning of the parts. It is equal to the difference in the dimensions of the mating parts.

A tolerance is the permissible variations allowed for commercial manufacture of the parts. The designer may decide on a certain allowance; he will then fix a tolerance on the allowance, thus fixing the maximum and minimum allowance acceptable. He will now fix a tolerance on each part to ensure that without selection of parts any two mating parts will fall within the prescribed limits of allowance.

Limits of allowance are the extreme dimensions prescribed for permissible variation in the quality of fit. These limit the amount of clearance or interference between mating parts. Limits of tolerance are the extreme dimensions prescribed for permissible variation in the size of each of the mating parts. Clearance is the amount by which the inner of two mating parts is smaller than the outer. Thus a bolt of 0·500 in. dia. in a hole of 0·510 in. dia. will have a clearance of 0·010 in. Interference is the amount by which the outer of two mating parts is smaller than the inner. Thus a bolt of 0·500 in. dia. forced into a hole of 0·497 in. dia. was provided with an interference of 0·003 in.

Selective Assembly

As already explained (see page 249), when the desired accuracy of mating parts involves burdensome production costs the expedient known as selective assembly is sometimes resorted to. The most reasonable tolerance is decided on for each mating part and limits

are fixed accordingly. The parts are machined to these limits and on inspection are graded into a definite number of size classes and the grades are matched according to appropriate classes.

The pistons for automobile shock absorbers are sometimes finely matched to their casing bores in this manner. Taking this example, suppose the limits of allowance are ·001 to ·002 in.; that is to say, suppose the clearance between the piston body and the casing bore must not be less than ·001 in. and not greater than ·002 in. Suppose further that the tolerance for both piston body and casing bore is ·0015 in. The desired allowance can be assured by grading each component into three class groups, thus—

Class Group	Casing Bore	Piston Body
A	1·5000 1·4995	1·4985 1·4980
B	1·4995 1·4990	1·4980 1·4975
C	1·4990 1·4985	1·4975 1·4970

Any piston which falls into Class Group A will mate satisfactorily with any Class Group A casing and so on.

CHAPTER XXXIII

LABOUR ADMINISTRATION

HAVING established the factory, installed the plant, and arranged the flow of materials, the organizer has still the final major factor of production to organize—the human element. The first step is to investigate the labour requirements and then to set up a suitable organization for obtaining and retaining the men who can best perform the work required. This will involve testing and training of applicants and then of the adoption of various schemes to keep the worker contented while controlling an adequate return for the wage paid.

Employment Department

In small factories the new employee may be interviewed briefly and engaged by the foreman or works manager upon the "hit or miss" principle, i.e. if the man is unsuitable dismiss him and try another. Such a method is obviously unsatisfactory, not only to the unfortunate man concerned but also, in view of the high cost resulting from the waste of material and time, to the firm.

In the more progressive factory, a special department will be set up for the engagement of all workers, and the control of all subsequent labour relations. This department will not rely entirely for its applicants on those who approach the firm, but will advertise their needs more widely and enlist the services of the employment exchanges so that by sifting over a wider range of applicants there is a greater chance of finding those who by reason of experience, age and physique will yield a higher standard of work. The applicant will be interviewed by the employment manager, a man who can handle the prospective employee with that element of friendliness and understanding so necessary at a preliminary interview to discover the real abilities of the new-comer. This is an office demanding tact and a knowledge of human nature, coupled with the ability to handle men not only in the preliminary interview but also in the difficult times when subsequent disagreements may arise between workers, for the duties of this department do not end with the engagement of the worker but continue during his employment, to see

that he is correctly and happily placed. When later difficulties arise, they must seek a remedy so that a good worker can be retained. This may mean a transfer from one section of the factory to another and such an independent department can act as a co-ordinating link between these various sections.

Records will be kept of all employees giving not only the full data obtained on his engagement but also tracing his history during his engagement with the firm and the reason for his leaving when he severed it. These records are best kept on cards, one for each employee, and will provide the information for promoting, transferring, dismissing or recommending a worker. A typical card, which is largely self-explanatory is shown in Figs. 83 and 84.

Name .... No. ....

Address .... Dept. ....

.... Age ....

References from (*a*) .... (*b*) ....

Single .... Married .... Physique ....

Training: Day School .... Evening School ....

College .... Apprenticeship ....

Previous occupation(s) ....

Date engaged .... in .... Dept. as .... Wage ....

Alterations in Wages—

(1) Date.............. (2) Date.............. (3) Date.............. (4) Date..............
Rate.............. Rate.............. Rate.............. Rate..............

(5) Date.............. (6) Date.............. (7) Date.............. (8) Date..............
Rate.............. Rate.............. Rate.............. Rate..............

Transferred from	to	on	as	Reason

FIG. 83. EMPLOYEE'S RECORD CARD (*front*)

PERIODICAL REPORTS

Year Ending	Days Absence		Times Late	Hours O'time	Bonus Earned
	Leave	Sick			

Date of Leaving ....
Reason ....
....
Conduct ....
Work ....
....
Report of the Employment Manager ....
....
....
....
Remarks....................
....
....
....
....

FIG. 84. EMPLOYEE'S RECORD CARD (*back*)

Job Analysis

Before the best man can be chosen to perform a certain task it is necessary to discover the exact characteristics of the work. It must be analysed and dissected into its separate operations and the skill or strength necessary for each noted so that the employment manager can have exact data upon which to judge the kind of worker who can best carry out the duties required. It is a common practice for Job Specifications to be compiled for each class of work in the factory and filed in the Employment Department, so that when extra or new men are required, the foreman, or departmental manager, can, in requisitioning for new men, merely specify the jobs which are to be filled. The complete information then available will reduce the possibilities of misfits. Such a job specification card should embody the following information—

(1) A brief description of the work, describing it as light or heavy, repetitive or varied, etc.

(2) The conditions under which the work will be done, such as may affect the choice from a physique point of view, e.g. dusty or outdoor, etc.

(3) The type of man normally required, i.e. whether young or old, skilled or labourer; educational or temperamental factors, etc.

(4) The rates of pay ruling for the work as well as the prospects of increases or of promotion.

A typical card is illustrated in Fig. 85.

Job .... Index No.

Department ....

QUALIFICATIONS REQUIRED

Male	Female	Unskilled ....
Semi-skilled	Skilled	High Technical Education ....

NATURE OF WORK ....

....

SUMMARY OF NATURE OF WORK AND CONDITIONS

On Floor	Standing	Heavy	Quick	Dangerous ....
On Bench	Sitting	Medium	Slow	Exacting ....
On Machine	Stooping	Light	Repetitive	Rough ....
Outside	Walking	Hot	Dusty	Dirty ....
	Cold	Damp	Fumes	Clean ....

WAGES

Per Day	Per Piece	Unit	Overtime	Bonus ....

Increases (1) .... (2) .... (3) ....

Prospects of Promotion ....

Normal Learning Period .... Knowledge of the Tools Required ....

Special essential qualifications ....

REMARKS ....

FIG. 85. JOB ANALYSIS CARD

Selection and Engagement of the Worker

Considerable developments have been made in recent years in the technique of selection of workers and much more scientific methods are now adopted to discover the total of an applicant's achievements and character so that the choice can fall only on those who possess the fundamental characteristics necessary for the particular job. The old method relied entirely upon the judgment of the manager at the interview but modern practice amplifies this with the more scientific measure given by trade, analytic and intelligence tests.

The purpose of the interview is to determine by questioning and personal judgment the general suitability of the applicant. Much can be gleaned as to his training and history, and an idea as to his moral and intellectual background. That vague attribute, personality, which is so vital if promotion to administrative posts is going to follow, can only be judged by this personal contact. The interview should always take place in a private room and should not be hurried. The applicant should first be put at his ease and then allowed to tell his story in his own way assisted and guided by a few judiciously chosen questions.

Unfortunately the interview can give no real idea of skill or manual dexterity, and employers in the past have overcome this difficulty by engaging men on trial. A better solution is to set the applicant a test which will measure his ability to perform the work required of him. These trade tests are so devised that in the performance of a task, very similar to the job, there is involved all those abilities required for the job itself. This is worked by the candidate under standard conditions and following standardized instructions, so that it almost resembles a very short period of probation. The result of the test is measured against a standard built up from experience so as to indicate those applicants with the highest grade of skill.

Trade tests measure the man's ability to do his job, so are of little use to test beginners or to compare persons who have had different amounts of training or experience. For these, trade aptitude or analytic tests have been devised which do not seek to determine what a man knows about the job, but what natural capacities he has for learning the type of work for which he is applying but for which he has, as yet, no skill. The different abilities necessary for the job are first analysed and simple tests are then devised to measure each

of these separate abilities. Thus the assembly of the small parts of a motor requires quickness, finger dexterity and ability to distinguish between small pieces of metal. A test devised to measure this required the applicant to pick out of a tray containing pieces of metal all those triangular in shape and to drop them into a slot in a moving wheel. The time taken and the method of performance, as measured against a standard, served as a guide to the applicant's ability for this particular job. The National Institute of Industrial Psychology have done much in the development of this class of test in this country though it is only right to say that too much reliance should not be placed on the results of this class of test until its accuracy has been proved in actual practice.

There is another class of test designed to measure the general mental capacity of the applicant irrespective of any training or experience in any particular direction. These are referred to as Intelligence Tests and aim at grading individuals in ranks from the stupid to the brilliant. In the selection of men for those jobs which require intelligence as well as for those which do not, the results of these tests can be most useful since as much harm is done by placing an intelligent person in a job of a dull, monotonous character where no initiative is required, as by filling a job demanding intelligence with a person of little intellect.

The interview and tests completed, the decision can be made of rejection or acceptance. This decision may in some cases be made by the employment manager alone, or alternatively, the employment department may submit two or three approved persons to the departmental manager concerned for him to exercise the final choice. Which is the best of these two alternatives, or of the many intermediary variations of these which may occur in practice, depends probably upon the actual circumstances of each case, and no fixed rule can be laid down unless it be to remark that it is generally wise not to engage a new worker for a shop without letting his future shop supervisor have some say in the choice, since it is often said that only a craftsman can really determine the ability of another craftsman.

On offering the position to the successful applicant, some formal acceptance on his part of the wages, hours and conditions of employment should be obtained after making quite sure that he understands them. If, of course, he is a trade union man this will be a very simple

formality, otherwise it must be gone into thoroughly. Some firms, especially those where there are some unusual or special conditions of employment, as in the handling of dangerous goods, etc., have a definite contract drawn up in writing to be signed by the applicant before he is engaged, and a copy is given to him for his retention after his notice has been drawn to the special features.

Our new employee must now be introduced to his job. At this stage he will be told something about the company and its policy in the treatment of the workpeople and in such other respects as may affect him. Any special schemes for the benefit of the workers will be described to him before he is taken into the shop and there introduced to the foreman who will instruct him in his new duties and outline any special working rules to him.

Promotion and Discharge

The duties of the Employment Manager towards a worker do not end when they have placed him in the job, they may rather be said to have just begun, for the best man having been obtained for the vacancy, the conditions must be set up for getting the best work from him. Almost the first thing a new employee will do on his entry to the firm will be to look around to see what prospects there are of his subsequent promotion. Most men have the natural feeling of hope and aspiration within them to make progress and will not be satisfied with permanent subordinate positions. If this desire is cramped and restrained, the worker quickly becomes inefficient and discontented from his lack of opportunity to develop his powers and satisfy his craving to handle the higher things for which he feels capable.

Hence, some definite scheme of promotion must be in operation in the works and must be well known and understood by every worker. Each must know in which direction his next promotion step will lead him so that he can clearly see the opportunities ahead. It may be advisable to let it be known that when any vacancy arises, provided there is on the staff some person sufficiently qualified to hold the position, it will be filled from within by promotion and not by the introduction of some one from outside. This gives a real incentive to effort. The firm may go further and assist their staffs to train for promotion by letting each man understudy his immediate superior so that in addition to his daily job, an employee also has

the two duties of training his junior and studying the work of his senior. This not only facilitates promotion and ensures that the new man really does know the job, but also provides an excellent reserve force of trained men to fill temporary absences by sickness or holidays. Incidentally it also ensures that no man is really indispensable—often a wise step from the business point of view.

Occasions will arise, however, when it becomes necessary to discharge a worker. This should be done by the Employment Manager, and not by the foreman, lest this arbitrary power be abused by the latter and the morale of the workers affected. The official should make a report of the cause to the Employment Department who will make such an investigation as they may deem necessary, since a man should only be dismissed for a justifiable and explainable cause. In some cases the reason may be one peculiar to the particular section where the workman has been engaged, and the Employment Manager may decide not to send the man out entirely but to transfer him to some other department where his services may be used without the peculiar difficulty arising. Difficult cases will sometimes arise where there is possibly an element of personal dislike on the part of the foreman in question, when transfer would appear to be the best solution.

The departing worker must also be interviewed, as often in the discussion light may be thrown upon some undesirable conditions within the works. If the man is a member of a trade union then the question may be fraught with more difficulties, and a tactful Employment Manager may find it advisable to have a few words with the union officials before action is taken to dismiss the man. By so doing, any subsequent dispute, or even strike, may be avoided by a mutual understanding in this early, friendly talk of the real facts at issue.

Labour Turnover

This is the ratio of the number of dismissals during a period (usually a year) to the average number of workers on the pay roll during the same period. If therefore a factory normally employs 1000 hands and during the year there have been 300 changes, then labour turnover will be referred to as $\frac{300}{1000}$ or 30 per cent. In comparing this figure, however, reference should be made to seasonal changes in the number of workers, for if in the above illustration

out of the 300 leavings, 200 arose because the factory had to close down one section owing to lack of work, then it would appear that only 100, or 10 per cent, left the firm's employ because of difficulties or grievances. Even this figure should be analysed further for a proper interpretation. Thus those who left on death, or for sickness, or women on marriage, may be eliminated. Of the remainder, a distinction should be drawn between skilled and unskilled, for there is often a greater tendency to wander in the latter than in the former.

The resultant figure is important as indicating to the firm a high loss due to these changes, especially when they can be avoided. Recent research has put the cost at anything between £2 and £50 per employee. The cost of finding, engaging and training a new employee is high, even in the most humble of occupations. In the early days of a worker's engagement, when he is learning his job, his skill is very much below average and output will be seriously affected. There is in addition the cost of work spoiled during training, especially when spoilage occurs in a late process so that it contains labour charges from all the earlier stages of production. There is also an increased proneness to accident on the part of these new employees while finally, mention may be made of its evil effect on the morale of the labour force.

The solution is obvious: to eliminate as far as possible the necessity to change the workers by retaining the old, as long as their work is satisfactory, by suitable schemes aimed at their contentment.

Training

The practice of apprenticeship is one which appears, in recent years, to be falling into decay, and the old system under which no man was considered a skilled workman or employed as such, until he had served three, five or even seven years' apprenticeship during which time he was learning his job under guidance of a skilled workman, is now the exception rather than the rule. The main cause for this is probably the development of the present machine methods where the worker is a skilled machine tender and there is no call for the personal skill of the craftsman. Those who in earlier days would have gone to learn skilled trades have been lured away from spending several years earning only meagre pay to the immediate high wages of the semi-skilled trades in the machine shops. The demand for

these semi-skilled machinists is at the present day high, while the need for skilled men for general work in the shops is falling. The present demand for skilled men still exists, but they are now wanted for foremen and other minor administrative posts.

Since the new employee is, then, usually untrained, there is need for some kind of direct training for the work he will be expected to do. The old method was to put the new employee alongside a skilled worker and require him to learn by imitation, helped possibly by some assistance or teaching from the skilled man (who might, in some cases, be allowed to credit himself with the extra output as a return for this diversion of his efforts). This was never satisfactory, for the skilled worker, though excellent at his job, did not always have the ability to convey his skill to another, for he may lack the art of analysis of his work into those elements which must be explained to make the whole clear. In practice there was also little incentive to the skilled man to undertake the troublesome task of training his new fellow workman.

This led to the foreman taking the new man in hand. The training usually resulting from this arrangement was certainly of a higher standard but otherwise the same defects remained; in fact it often proved more costly, since the foreman's attention was diverted from his major responsibilities.

It is obvious that the best solution is to have special instructors, men who are not only skilled but who have in addition the ability to teach and the opportunity to do it successfully. This has led many firms to establish a special training shop with materials and machines used only by these learners and separated from the factory proper. Here, these instructors can devise methods that will enable the new worker to get a quick insight into what is required and gradually train them under working conditions to perform the job correctly and to obtain working speed. There may be added before the man goes into the shops some instruction about the general business of the firm or any other general facts which may help to make him a better employee.

The expense involved in the adoption of these training departments is well worth while, especially in those factories where, in the use of expensive raw material or valuable machinery, much waste or damage can be prevented.

Emphasis has already been laid (page 13) upon the importance of

the foreman in the work of a factory and for the filling of these vital positions many firms have instituted foremen training schemes. Classes are held for those workmen who are thought qualified to benefit from the preliminary training. These classes of aspirants for foremanship will be quite separate from other study groups for existing foremen. The latter will gather in small groups at regular intervals, usually in the firm's time, for discussing practical problems of foremanship and minor administration under the direction of a trained leader. Formal training will amplify the study groups so that ideas and facts for the discussion will not be lacking.

This formal training is often purchased from a commercial training college in the form of printed lessons to be supplied to the men with test papers, and amplified possibly by oral lectures. It may, alternatively, be wholly oral and be obtained at one of the many technical colleges which exist in this country. These courses are designed to give instruction in the general principles of business and of foremanship with such extra courses as bear on the specialized work of the firm, e.g. electrical engineering, telephony, building construction, etc.

It is wise for an employer to investigate the form of training which these classes receive from these general courses, since it is often quite easy, and possibly more effective, to prepare special courses for the business in question. If the number of trainees merits it, most technical institutes will be only too pleased to inaugurate special classes to meet the peculiar needs of these men, classes lectured by specialist members of the firm itself as well as by outside specialists in other subjects, so that the exact requirements of the men are satisfied and the best gain results from their labours. If a local technical institute is not available, special correspondence training on these lines can be obtained without difficulty, and at a very low cost, from private institutions.

The idea of training foremen to do their jobs better will first have to be shown to all concerned to be really worth while, for the idea is still new to many executives who cannot believe (what is known to be true) that more benefit will result than it will cost, and to be successful the heads of the firm, especially on the works side, must co-operate and take an active interest. The gatherings must not be regarded as social, though this element must not be entirely lacking,

nor must continued and concentrated study be demanded from mature men, though again a reasonable standard of work can be required.

The Health of the Workers

Ill health in a worker causes industrial waste from decreased efficiency and absenteeism, increasing costs from possible accidents and considerable discontent. It, therefore, pays any concern with a large number of employees to pay some attention to the health of its workers. Reference has already been made elsewhere to the conditions of work which have their adverse effects on health, under the respective headings of ventilation, etc., and it is here necessary to review those services necessary to maintain the health standard at its maximum.

In firms of moderate size situated in large towns, a limited medical service is often provided by the employer to cover such matters as accidents or emergency illness, and periodical examinations, the normal services being provided to the workers by their own private medical attendants. In large establishments situated away from a town, and in mining and similar industries where serious accidents are possible, a more comprehensive medical service may be maintained, towards the cost of which each employee will be required to contribute a few pence each week. This service will give in addition all medical and surgical treatment a worker may need, as well as in certain cases specialist attention to teeth or eyes, and a visiting nurse or home nursing service may be inaugurated.

These services will be housed in a separate department, often set quite apart from the works with dispensaries and sick ward, facilities for physical examinations, treatment and dressing of injuries common to the type of plant, and for the emergency treatment of illness and dispensing of medicines. These are often in practice model institutions.

Safety and Accident Prevention

Increasing attention is being paid by factory administrators to the prevention of accidents, for it has been found well worth while, quite irrespective of legislative enactment, to make the conditions of work as safe as possible and teach the workers to avoid accidents. This is not solely for altruistic reasons but to reduce the amount

which may have to be paid as compensation and to prevent damage to plant and machinery and minimize working time lost.

Of late, the legal aspect has assumed considerable importance. The Factories Act, 1937, demands attention to the safeguarding of workers to an unprecedented degree. Factory owners must answer for the consequences of accidents occurring in their premises and are responsible for the protection of workers by suitable machine guards and fencing. As an indication of the demands of the Act, consider the following extracts taken at random—

"Every part of electric generators, motors and rotary converters, and every flywheel directly connected thereto, shall be securely fenced unless it is in such a position or of such construction as to be as safe to every person employed or working on the premises as it would be if securely fenced."

"Any part of a stock bar which projects beyond the headstock of a lathe shall be securely fenced, unless," etc.

The Act is also concerned with such matters as adequate factory lighting the hours of work of female and youthful workers, the operation of hoists, cranes, etc.

An investigation into the cause of industrial accidents has shown three major causes—(*a*) mechanical breakdown; (*b*) physical and mental causes (over-fatigue, worry, lack of training, etc.); (*c*) carelessness. Any system of prevention will therefore attack and eliminate the causes as far as possible.

Mechanical breakdown can be reduced to a large extent by a proper system of plant maintenance under the guidance of skilled engineers as has been described in Chapter XXXI. Additional precautions in the form of guards and casings may be used while the introduction of a mechanical fuse (see page 239) will often prevent a serious accident from any overloading or jamming of a machine. Proper attention to the health and welfare of the worker and the conditions of work, as discussed elsewhere, will do much to eliminate accidents from the second cause so far as it arises within the factory, though in some cases these factors may be affecting the workers out of working time.

Much can be done to eliminate carelessness by a system of continual education of the workers in safety-first principles. Many posters of a very striking appearance with striking captions have been devised for exhibition in the factory, showing what *not* to do

and revealing the awful consequences of careless and unthinking acts. This attempt to make the workers safety-conscious and to protect the lives of themselves and their fellow workers is the best way of combating this third cause of accidents.

Many factories have established first-aid training for those workers who are interested so that upon the happening of any accident, however small, immediate treatment can be given pending the arrival of the physician. The cost of this training, usually given in collaboration with the local St. John Ambulance Brigade, is very small, especially when compared with the benefits. It is advisable for the administrator to make a careful study of the accidents that occur in his own establishment so that by analysis the weak points of the organization can be seen and safety provisions introduced where most required. Thus it may be noticed in what departments, to what class of workmen, at what time of day, etc., accidents usually occur.

There has been established by the Home Office, for the purpose of assisting industrial concerns with this question of accident prevention, an Industrial Museum (situated at Horseferry Road, Westminster, London) at which a very comprehensive display is available of the various devices from mechanical guards to elaborate posters. Every executive should make a point of visiting this free display (it is certainly not the musty place the word "museum" conjures up!) where much practical information can be gathered on these vital questions of safety and working conditions.

Fatigue

Fatigue is the feeling of weariness from continued work, which may vary in degree from mere boredom to absolute exhaustion. It is caused by poisons generated in the blood which in light, varied work can be cleared as they are generated, while in heavy work they accumulate until rest becomes necessary. The causes of abnormal fatigue in a worker have been found to fall in most cases within one of the following four major classes. The length of the period of work may cause fatigue by the mounting up of the poisons in the system if no opportunity is given of freeing the system. It is largely because of this that overtime is regarded as so unsatisfactory, since after the ordinary working day any further duty may cause injury to health as well as a lower standard of work done.

The speed of the work may also cause more toxins to be produced than can be cleared, and fatigue results. This is especially so in modern machine work where the pace is set by the machine and there is the constant demand upon the worker to keep up with it. If the work done is such that it requires the worker to repeat the same operation constantly during the day, an operation working just a portion of the brain and body at a fast speed, fatigue may result at an early stage unless precautions are taken. Noise can also have an important effect on output. In a north of England firm the elimination of certain noisy machinery from a room in which girls were working, resulted in an increase of nearly 20 per cent in output mainly because of the quieter conditions.

The modern development in the solution of the problem of fatigue of the worker is the introduction of rest pauses. This is an enforced breaking off for a few moments from duty by the worker at those moments when investigation has shown that fatigue is just beginning to show itself. These moments of rest allow the body to recuperate and overcome the blood poisons so that work can be renewed with vigour and interest, and without the lassitude which would otherwise have ensued. In the past "rest pauses" were often taken unofficially by workers, so that nothing is really lost, while the effect of authorized rests is so much greater that output is definitely improved, especially in the case of workers engaged on repetitive work.

The length of the pauses, their number and incidence can be determined only after research. They are best introduced at the moment when the working activity has just passed its peak and is beginning to fall off, showing that fatigue is just showing itself.

Much can also be done to eliminate fatigue by attention to the light and situation of the work, the height of the bench, the location of the working tools, and the seating arrangements. Considerable information on this question has been made available by the Industrial Health Research Board.

Welfare

The various schemes adopted in modern business for securing the co-operation of the workers are commonly referred to as welfare work. Many of the activities of this labour department have been dealt with above under the headings of health, training, safety, and fatigue. The remaining elements of personal administration lay in

various financial schemes and in matters of leisure employment. These latter evidence themselves in practice in ways such as sports clubs, club rooms, dramatic societies, orchestras and glee parties, etc.

Even these recreation activities on the part of a firm pay good dividends, for they can contribute to a large degree towards the health and efficiency of the workers and their contentment and loyalty. Under the leadership of efficient promotors and organizers they rarely fail to be successful. They should be left mainly in the hands of the workers, and the employer should not interfere to any serious degree, yet at the same time a great deal of good can be done if the employer will show a proper and lively interest in their activities. The worker should be called upon to make some slight contribution to the cost, though the most of financial outlay will probably have to be borne by the business.

The running of a club house or social hall can often be a vital factor in building up a corporate spirit amongst the workers. Such buildings vary from the large ex-army hut to the elaborate building with separate rooms for billiards, reading, cards, library, etc. It may be found a wise plan to combine a canteen with the club house, using the room during the day for meals sold to the workers and in the evenings as a club.

The introduction of a canteen will ensure that the workers obtain a proper mid-day meal at a cost well within their pockets. Some employers hold that the gain in the afternoon work by the abolition of the mid-day "sandwich snack" would almost merit giving the mid-day meal free, though this is seldom necessary. They are usually run on cafeteria lines to eliminate the need for service, and provide one or two dishes. If the workers, through a representative, are allowed to exercise some measure of control over the supplies of food, many complaints which might otherwise arise can often be prevented.

In some of the larger factories a welfare officer or mutual service worker is employed and is usually attached to the employment manager's department. His real function is to assist employees to better their conditions, it being realized that this tends to reduce labour turnover—a source of waste not yet fully appreciated in many concerns.

Well directed welfare activities such as recreation, sport, indoor

games, savings, and education, add to the comfort, convenience, and general welfare of the employee, increasing his morale, and tending to promote that stability which follows contentment and satisfaction.

Financial Incentives

In the relationship between employer and employed, the choice of a suitable method of wage payment is of vital importance. It would probably be not far wrong to say that the real reason for the efforts of the average worker is to earn sufficient money with which he can obtain the necessaries and comforts of life. The problem before the employer is therefore one of selecting such a method of remuneration as will not only give to capital a sufficient margin of profit, but will also give the worker a financial incentive sufficient to secure his co-operation and the maximum output of which he is capable.

Whatever method is adopted, however, it must give the employer a fair return of work of good quality within a reasonable time and without waste and, moreover, without affecting the morale or health of the workpeople. To be satisfactory, the wage payment must also be adequate to maintain the worker in a reasonable standard of living, be calculated on some basis that is clearly understood by every one affected, a base that is really fixed and not one that can be varied at the whim of the employer, though which, nevertheless, should be sufficiently flexible to permit variation to meet changing conditions.

The many systems of wage payment may be roughly divided into two classes: (1) the payment of the worker for his services during a period of time, i.e. time wage systems, and (2) the payment for a certain amount of product, i.e. payment by results. Under time-wage methods the worker is paid by the hour or week or month, without regard to the quantity of his output. There is no financial incentive for him to work harder than may be just necessary to retain his job. No doubt many workers will have a real interest in their work (and proper treatment and personnel management can do much to develop this), but there is nevertheless always the tendency to take longer than is really necessary. A further flaw lies in the fact that workers of varying efficiency are paid the same wages. Yet, where quality of output is of greater importance than

quantity and any speeding-up may result in greater waste of material than time gained, or where it is impossible adequately to measure the extent of a man's efforts (as in the case of plant maintenance), then time wages can prove to be the best method, especially if it is coupled with a close system of supervision.

There is a scheme adopted by Mr. Henry Ford and other manufacturers, known as the High Wage Plan, whereby time wages at a higher rate than is usual in the trade are paid, but they are coupled with a very close control on output. It has been found that the high wages attract the best workers who, eager to retain such remunerative employment, put forward their best efforts and so produce results high in quality and quantity, more than compensating the firm for the high level of wages paid.

The simplest form of payment by results is plain piece work, i.e. wages paid according to the value of the quantity of work done irrespective of the time taken, though there is often a guaranteed minimum below which the amount paid per hour or week shall not fall so that a minimum living wage is guaranteed to the worker. In those cases where conditions are standardized so that so much effort always produces a fixed amount of output, and where the quantity of that output is capable of simple measurement, piece work methods can be attractive to the workers. From the employer's point of view, if his overhead expenses include a large bulk of standing or fixed charges (i.e. those which do not vary with output) then the spread of these over a greater output lessens the cost of production per unit. One point must be mentioned: when a piece rate has been finally fixed, it must never be altered unless there are sound reasons, clearly apparent to the workers as well as the employers, for their reduction. It is invariably found that there is greater need for inspection of the work when this method of payment is adopted, as the worker's aim tends to be quantity irrespective of quality, though the cost of extra inspection should not exceed the gains from the increasing output and the greater satisfaction and independence of labour when paid according to their efficiency.

The employer's gain in piece-rate methods is largely a financial one by the reduction per unit of production costs, and when part of this financial gain is shared with the workers, the wage method is described as a premium bonus system. There are a great number

of actual varieties, mainly differing according to the actual division of the gain between worker and employer. Most of them set a limit of output below which no bonus is paid while above that limit the bonus may be fixed, or may be on a sliding scale based on hours taken to do the work or the quantity produced in a fixed time, etc. Detail description of these is beyond the scope of this book, though mention may be made of the better known such as the Halsey, the Rowan, the Taylor, the Gantt, the Emerson, the Bedaux and Priestman.[1] Special bonuses are often added for timekeeping or deductions made for spoilt work, etc., the intention being to reward efficient work.

There is a class of wage payments referred to as sliding scales, one of the best known being those based on the Ministry of Labour Cost of Living Index figures, the intention being to give a varying rate of money wages that shall result in a constant amount of purchasing power. When applied to that class of people upon whose wage and in that particular region from whence the statistics have been drawn for the compilation of the index, it can no doubt work very well, but its widespread application is possibly hardly desirable. In some industries wage agreements exist under which wages are revised at periodical intervals and raised or lowered according to the rise or fall of the selling price of the product they are producing. In some sections of the iron and steel trade wages are revised quarterly on the basis of prices ruling in the market for pig iron and finished iron and steel. These agreements have been keenly criticized, for it does not seem right that wages should depend on supply and demand for the product or on the sales policies of the firm, matters not under the control of the workers themselves.

A further scheme of financial incentive is profit-sharing, though it operates independently of the wage system and is not intended to take the place of any part of the wage, but is in addition to these payments.

Profit-sharing has been found successful in some concerns and, while practical details differ, its general form is usually to distribute amongst the workers, in proportion to salaries received during the year, a portion of the profits earned by the business at the end of the financial year. It is claimed in favour of this system that it will

[1] For further information on these and other methods the reader is referred to various other works of the present publishers.

increase the worker's interest and efficiency, will maintain his loyalty and reduce labour turnover. The critics, however, point out that individual workmen by their efforts can hardly affect the profits of the whole concern which are subject to so many other influences, outside as well as inside the business. While it is possible to share profits, the plan appears possibly weak when losses arise, for workers can hardly share these, and in such times the non-receipt of the expected bonus might cause considerable disturbance amongst the workers.

Profit-sharing has been extended in some cases to a system of labour co-partnership whereby employees are helped to acquire a share in the capital and a voice in the control of the business in which they are employed. It may take the form of assistance by loans or other aids to enable the worker to buy shares in the capital, or possibly special co-partnership shares with dividend rights, but restricted voting rights may be created and given to the employees, thereby enabling them to get an interest in the concern. There is usually associated with this plan, the formation of works committees constituted of elected representatives of all ranks of the workers who have a voice in the internal management, especially in matters affecting working conditions, wages or other points closely touching the employees. Frequent meetings are held (partly in the works' time) under the chairmanship of the managing director and minor decisions may be made and put into force immediately, and more important matters referred to the Board for their confirmation of the suggestions put forward. These meetings can do much to keep alive the interest in the scheme in the long intervals between the bonus or dividend declarations under the co-partnerships arrangement.

Pensions to retiring and disabled workpeople are becoming increasingly popular in industrial concerns. After a worker has given many years of service to the firm he may be given a retiring allowance dependent on his years of service and his wages at the time of retirement, with minimum and maximum limits. Under some schemes the pension fund is provided entirely out of the profits and is not a contracted right of the workman, while in others the workers make a small contribution from their wages towards the fund. The former scheme is not looked upon with favour to-day since the worker has no legal claim to it and its security is dependent upon the firm being in a position to pay it. Most modern concerns

prefer to put it on a business basis and take actuarial advice as to its proper calculation, and the worker is required to contribute a fixed proportion of his wages. The contributions of the worker and employer are separately invested and placed in the hands of the trustees for administration. The pension is guaranteed and becomes not a question of doubt but a definite calculable amount. Should the worker leave the employ or die before pensionable age, he is often permitted to withdraw his contributions to the fund with interest at say, 1½ per cent p.a. It is generally advisable to keep separate the pension funds for male and for female workers since marriage will considerably disturb the administration of the latter.

Mention must be made of Suggestion Schemes which can do much to keep the workers' interest in their work and the firm, as well as improve the business methods. Under this scheme, workers are invited to submit to the management any suggestions they may care to make to improve working conditions or methods or reduce costs, etc., by writing them on forms and dropping them into boxes provided so that full benefit can be obtained of the brains of those most closely connected with the various details of the working process. These will be considered by a responsible official and if adopted there will be paid in cash an amount commensurate with the benefit resulting. Many firms can point to valuable schemes saving them hundreds of pounds which have resulted from these suggestions boxes.

CHAPTER XXXIV

METHODS OF CONTROL

THERE has been outlined in these pages a description of the whole of the elements which go to make up a complete factory, so that there only now remains to describe the co-ordination and directive unifying effort which will mould these together. These activities of controlling and directing the business are referred to as administration, by which is understood the work of determining the policy of the business and of co-ordinating the sales, distribution and finance aspects of the business with the production through the system of organization which is set up. The actual work of seeing that the instructions dictated by the administration are carried out and of supervising those efforts, whether human or machine, in attaining the objects of the business is the work of the management group of operatives. Hence, it can be seen that the structure of the industrial undertaking is composed of Administration, Management, and the Operation groups, which last is the group whose activities have been described in the earlier pages, and whose work is the performance of the detailed work of manufacture.

At the outset there must be clearly understood the aims of the concern, the *raison d'être* for its existence, which must be defined so that the board of directors, or others responsible for the ultimate control, can draw up the policy of the business. By policy is meant the outline method by which the aims of the business are to be achieved and forms a group of instructions for the direction of the management. This policy will have been founded on exact information, and has regard to all future tendencies showing lines which may be developed at some future date, and will cover not only production but also sales, finance and buying. Having laid down the policy the directors will need regular information from those responsible to see the results of this policy, so that any revision which may subsequently prove necessary can be carried out.

Organization

In order to obtain the results desired by the administration, the detail work must first be studied, and then assigned to suitable

individuals or to groups, so that the ends may be achieved effectively and economically by the co-ordination and combination of their efforts. This is what is understood by organization, which is the best means of achieving the ends desired. It will be noticed that just as in dealing with the plant and with the materials, planning of the lay-out, etc., is necessary, so it is with the third factor in production, the human element, which must also be planned and arranged so that the maximum efficiency can be obtained, though since the human element is being handled the problem is one of greater complexity.

In any business, then, the whole work to be done must be so allocated amongst the workers that it can be done with the minimum of effort, so that as little as possible shall be wasted, and the most obtained from each worker, yet the work of each man must be so arranged that it will fit in with the work of all the others, i.e. there must be a proper system of co-operation to get a real unity of effort in the business as a whole. The organization must be such that any expansion can be made or modifications can be effected without any disorganization. Finally, it must be borne in mind that human beings are being dealt with, so that their contentment must be considered.

The Military Type

From these broad principles several systems have been evolved, one of which is known as the departmental method of organization or the "Military" system. Under this system the activities of the business are first divided into the main groups, such as finance, production, distribution, etc., which are then again subdivided into several departments, each responsible for performing one or more of the processes of the whole group. The head of the department will be responsible for performing everything affecting that particular department, including in a productive department storage, tools, maintenance of plant, production, staff management, etc. Each unit is, therefore, self-sufficient with the manager in control, who will delegate duties to several assistants and they to their assistants. The system is simple for responsibility is clear, but unfortunately modern production has developed to such a degree that it is difficult to get any one man capable of acting as a manager or foreman to control all the details of a section of the works. Labour, Plant,

Costing, etc., are now developed so that no individual can be sufficiently trained to control them all to any degree of efficiency, so that the standing of the whole department falls because of the lack of ability of one man. Moreover, co-ordination of the work of the various departments is difficult, calling for exceptional qualities in the General Manager.

These difficulties have led to other forms of organization which are designed to make use of the division of labour and the specialization of skill. Of these, the two main forms of organization are the "Functional" and the "Staff and Line," both of which permit of factory growth without disturbance to the form of organization.

The Functional Type

As implied in its name, Functional organization is concerned with an analytical division of the separate functions of the production project. Responsibility is not divided according to processes or the location of departments but according to the functions performed, irrespective of the process or place in which it is performed. The several Functional foremen each have access to the same group of workers in the performance of their respective functions. It will be apparent that the utmost use is made of specialist skill. The expert of one particular function is allowed to act as the executive in charge of that function throughout the factory. It must be conceded, however, that overlapping of authority and duplication of labour are almost inevitable, the clerical expenses consequent on the necessarily elaborate system are heavy and co-ordination is difficult. The system is widely used in the U.S.A.

The Staff and Line Type

The form of organization favoured in Great Britain combines the advantages of the two former types. The staff of specialists perform the functional idea but they control the workers only through the foremen, who act as in the Military type. Thus the foremen are relieved of all planning and routine work and so are free to concern themselves with the teaching and control of their respective workers. The functional aspects are undertaken by

specialist departments, planning and progress, for example, where all work of an investigational or advisory nature is carried out.

Scientific Management

No discussion on management would be complete without mention of the methods adopted by a school of thought under the name of scientific management, developed first of all in America by F. W. Taylor from about 1895 onwards. This system works upon the following lines.

(1) Each individual job is closely studied and the operations closely analysed, noting speed of working, the tools used, the handling of the work, etc., so that it may be seen that the ideal conditions are present for the performance of the particular job.

(2) In this study the best way of doing the job will be ascertained by time and motion studies so as to eliminate all useless movements.

(3) This best way will then be made the subject of instructions to the worker, so that he may adopt it and accord to the standard amount of work which will be demanded from him each day.

(4) It having been seen that it is possible to do the job required in the given time, the requisite conditions for the work to be done will be maintained, and the exertion of the workman ensured by making payments on results to stimulate him to maximum effort.

It will be noticed that this system applies only to the actual performing of the work, so that it is naturally used in factories organized on the Staff and Line method, where the Planning, Preparation and Service Departments are separated from those engaged in the actual execution of the work where the organization is on functional lines.

Charts

It is essential for those in authority to be kept in close touch with all the matters concerning the running of the factory by a system of constant reports, carefully compiled, to give all the details about the past happenings to form the basis for future action. The handling of these reports should be such that all the details of a routine character are handled by junior officials, and only those figures which vary to any degree from the normal are brought to the attention of a senior executive.

These reports may be presented on forms showing the actual figures, alongside any budgeted or pre-estimated amounts for comparison of degree of accuracy with which the two have accorded. In addition, comparison figures may be added to show the results during the same period in the previous year, or in the period immediately preceding the one being reported upon. Cumulative

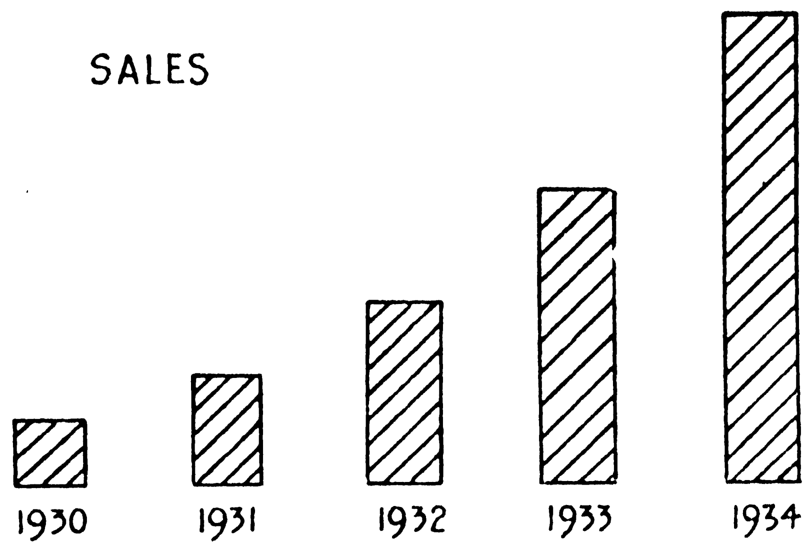


FIG. 86. SIMPLE BAR CHART

figures may also be added, showing the totals for the year up to date. These additional facts will aid the interpretation of the forms and add to their value.

But the presentation of facts in the form of a mass of figures is not very informative to anyone unaccustomed to their use, so that the method of presenting facts in one or more of the many available graphical methods is advisable. This not only gives the same information in a more easily read form, but also makes comparisons between interrelated facts and between several periods a much more simple matter since it is possible to see the trends at a glance.

One of the simplest forms of the chart is that used for displaying the organization of a business presenting the various elements in their correct order, with lines showing the flow of responsibility and of work.

A similar type of chart may be used for showing the flow of work from one machine or department to another, as was used in Chapter XXXI at Fig. 79. These charts give the required analysed information on any matter for the purpose of investigating and solving a problem of organization or of similar matter. Since the

matter is shown in such a vivid form, they may also be used for illustrating the facts of a matter to the executives for their consideration.

Bar charts are a simple form of expressing pictorially the relative

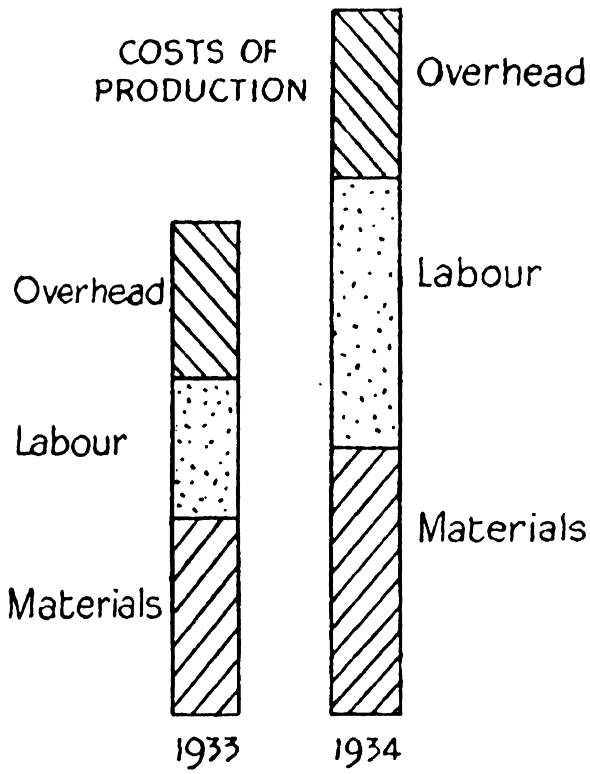


FIG. 87 (A)

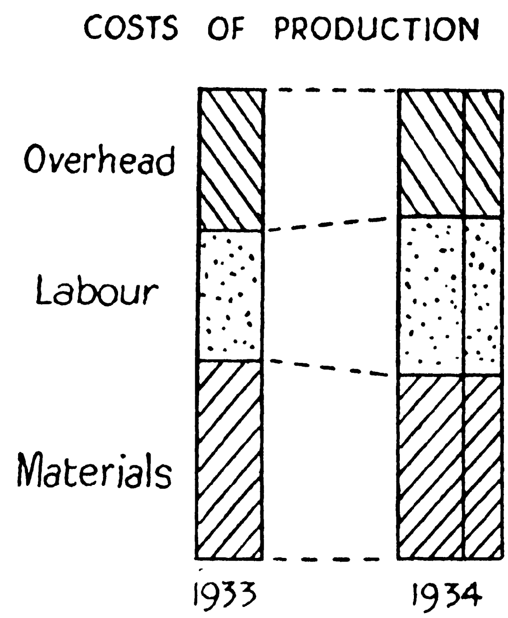


FIG. 87 (B)

magnitudes of several factors. They are very easily understood, and so are used in those cases where the matter is to be presented to those unskilled in the interpretation of graphs. In its simplest form the various elements are shown as bars of varying lengths standing on a constant base with the date underneath as in Fig. 86.

The bar chart may be further developed to show the amounts of the constituent elements composed in the totals as shown in

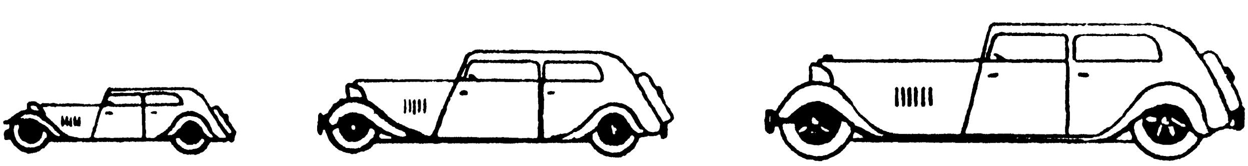


FIG. 88

Fig. 87 (A), but the difficulty with this chart is that the relative proportions of the various elements are not clearly shown for comparisons, i.e. while the whole is increased it is difficult to say if the proportions of the three elements have remained constant. This may be remedied by preparing an analysed bar graph of the percentages of the whole as in Fig. 87 (B), from which the changes in

the rates of the elements can be seen while the increase is shown in the thicker bar.

These charts lead naturally to the pictorial form where the relative values are shown, not as bars of varying lengths, but as pictures of the actual object of various sizes, e.g. a motor-car manufacturer would probably find it better to show figures of his sales for advertising purposes as in Fig. 88, since that would be more striking than any other form. These are rarely used for internal records.

A modification of the bar chart is the pie chart (Fig. 89) which, in circular form, shows the constituent elements of a whole, though in view of its circular form it is usually not so effective as the analysed bar chart described above.

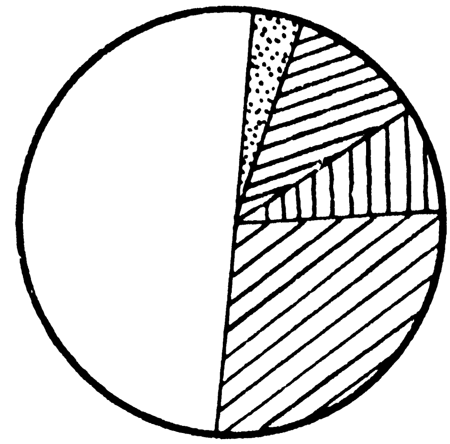


FIG. 89. PIE CHART

Mention must be made of the use of maps in charting information which varies with geographical location. Thus, travellers' areas may be marked out and pin flags inserted to show the daily location of each man, while the areas may be shaded to show volume of sales, density of customers, or the cost of transport from head office. Upon such a chart the movement of goods, etc., may be routed by coloured threads and pins.

The commonest method of showing results is by the graph or "historigram," where a moving line is plotted to record the series of facts on a chart with the time factor usually along the base, or horizontal axis, and the values on the vertical axis. A simple form is that in Fig. 90, which shows the monthly sales of a firm over a period. It will be seen that this line fluctuates somewhat, so that it is not very easy to watch the general trend of sales. In order to smooth out these irregularities, a moving average graph may be used. This graph is obtained by plotting the moving annual averages found by taking the total of the first twelve months and adding them together, dividing the result by twelve; at the end of the thirteenth month the sales of the first month will be dropped, and the average of the last twelve again taken, so the effect of any violent change in any particular month is levelled over the whole twelve. It is usual to show this average on the simple graph as a coloured or dotted line. It will be found much more informative

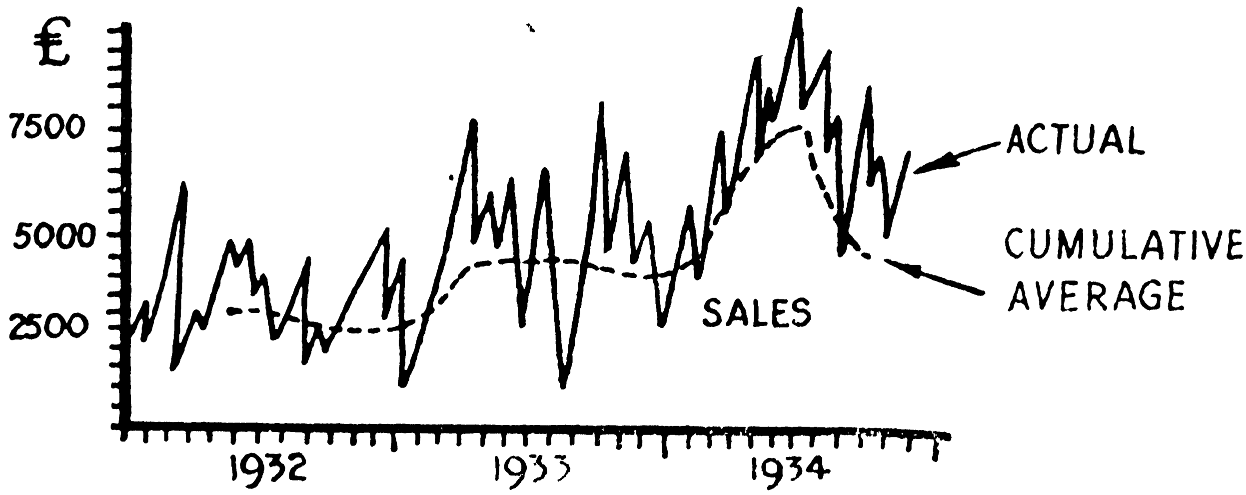


FIG. 90

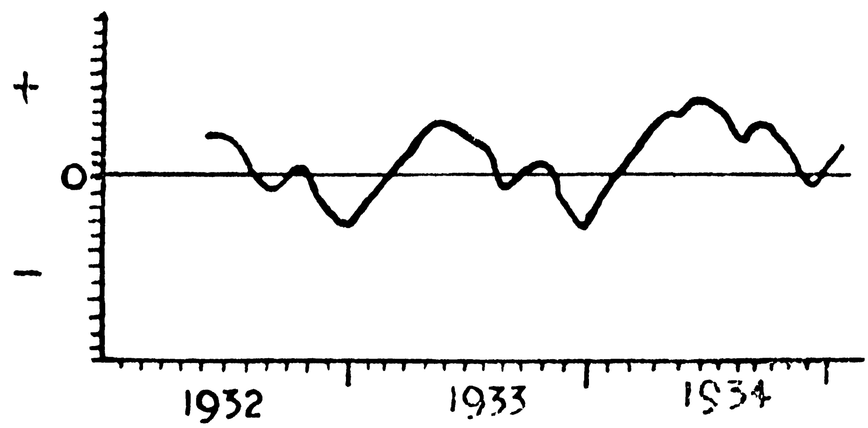


FIG. 91

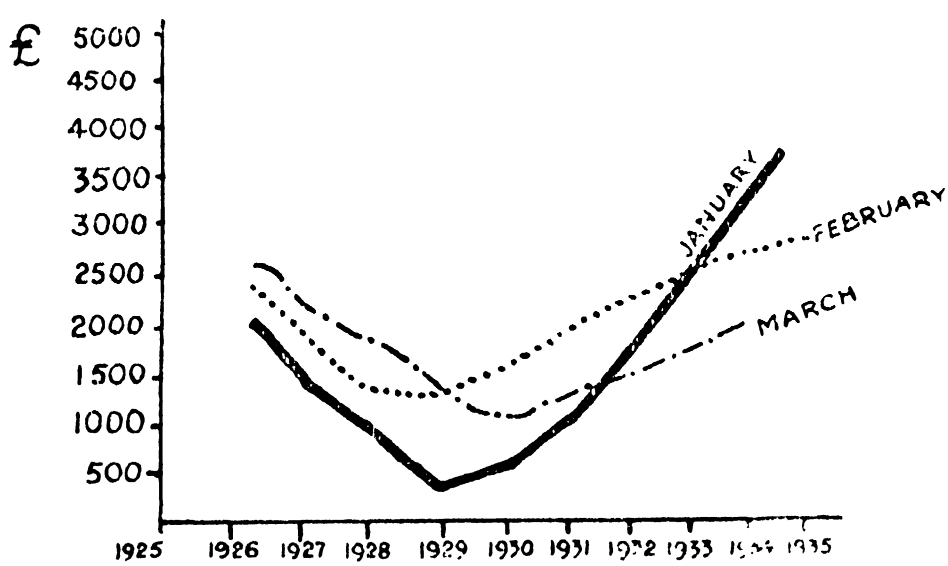
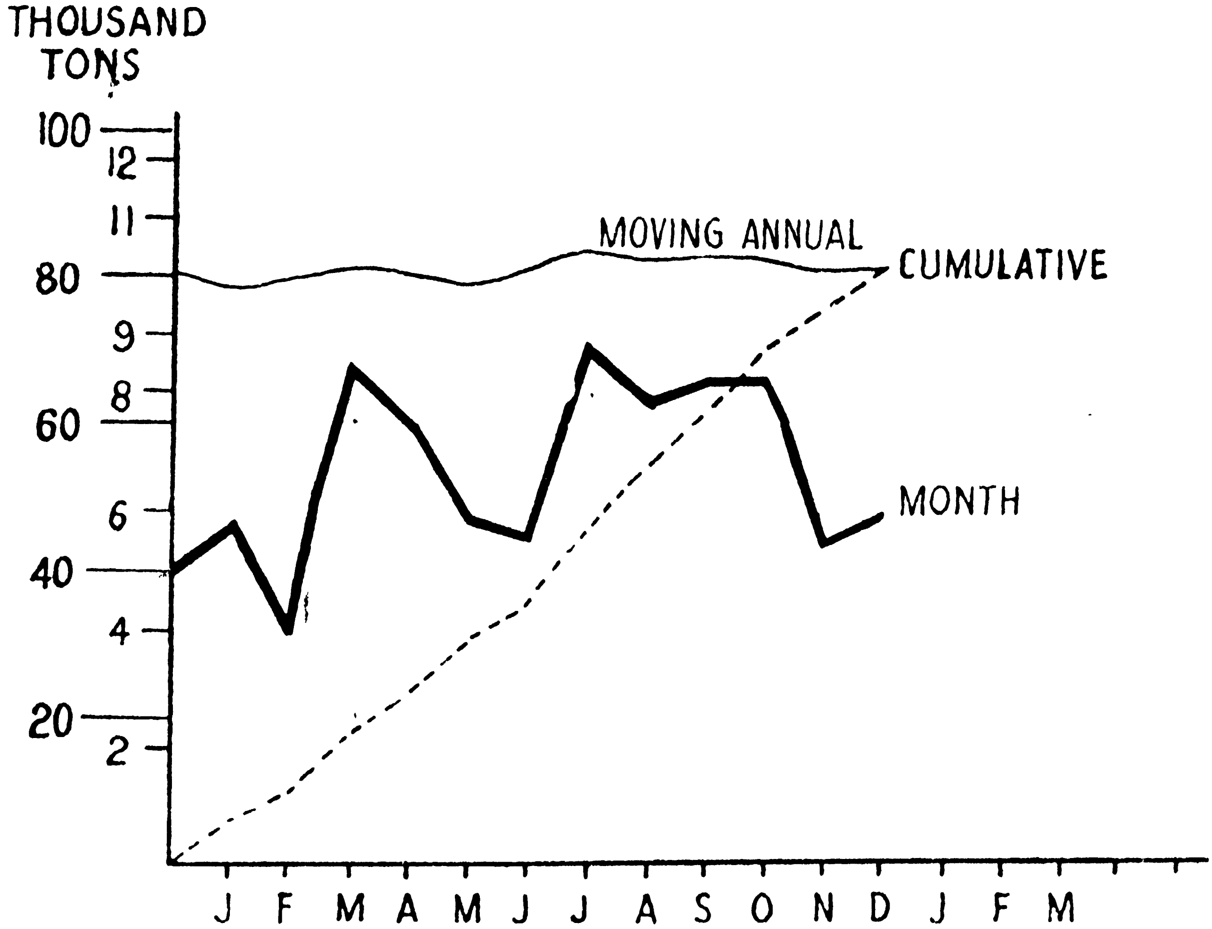


FIG. 92

for viewing past trends and estimating future movements than the simple chart. The seasonal divergences of these figures can be clearly shown by plotting the amount of the divergence of the actual monthly figures from the moving average figure on a chart with a centre zero line as in Fig. 91.

It is often desired to use these charts for comparison, so that a special chart may be compiled to show the figures of one month with those of previous years. In this case four charts may



	Monthly	Cumulative	Moving Annual Total		Monthly	Cumulative	Moving Annual Total
J.	5,503	5,503	78,800	J.	8,950	46,435	84,600
F.	4,020	9,523	79,050	A.	7,947	54,382	82,400
M.	8,530	18,053	81,400	S.	8,124	62,506	83,100
A.	7,450	25,503	80,900	O.	8,144	70,650	82,960
M.	5,837	31,340	79,500	N.	5,403	76,053	80,040
J.	5,145	36,485	81,000	D.	5,910	81,963	81,963

FIG. 93. Z CHART

be used, one for each quarter to prevent confusion of too many lines, so that the first quarter's chart may appear as in Fig. 92.

A special form of these charts was designed and patented by Williard C. Brinton in U.S.A. some years ago, and has come to be known as the Z Chart, because of the form that the three lines usually take on the chart. The principle involved is to plot the actual figure with the cumulative figures, and the moving annual total on the same sheet. As, of course, the first is much less in magnitude than the last two, two separate scales are provided (see Fig. 93).

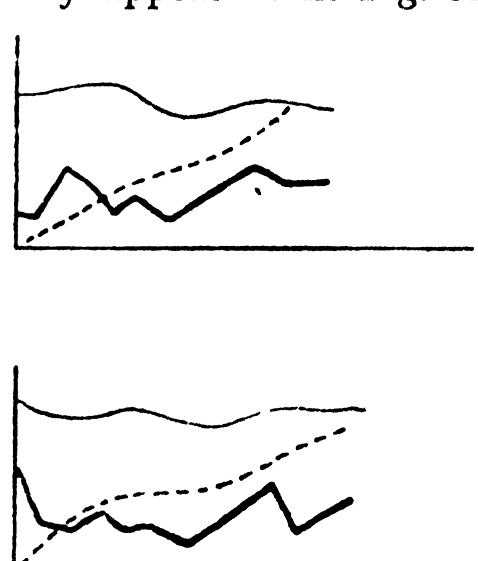


FIG. 94. COMPARISON OF Z GRAPHS

By taking two of these charts and placing them side by side, i.e. continuing the second year's chart on the same sheet as the first year's, the heights of the curves and the general trend of change over the years may be compared. For seasonal comparison, however, the curves are better placed one above the other, as indicated

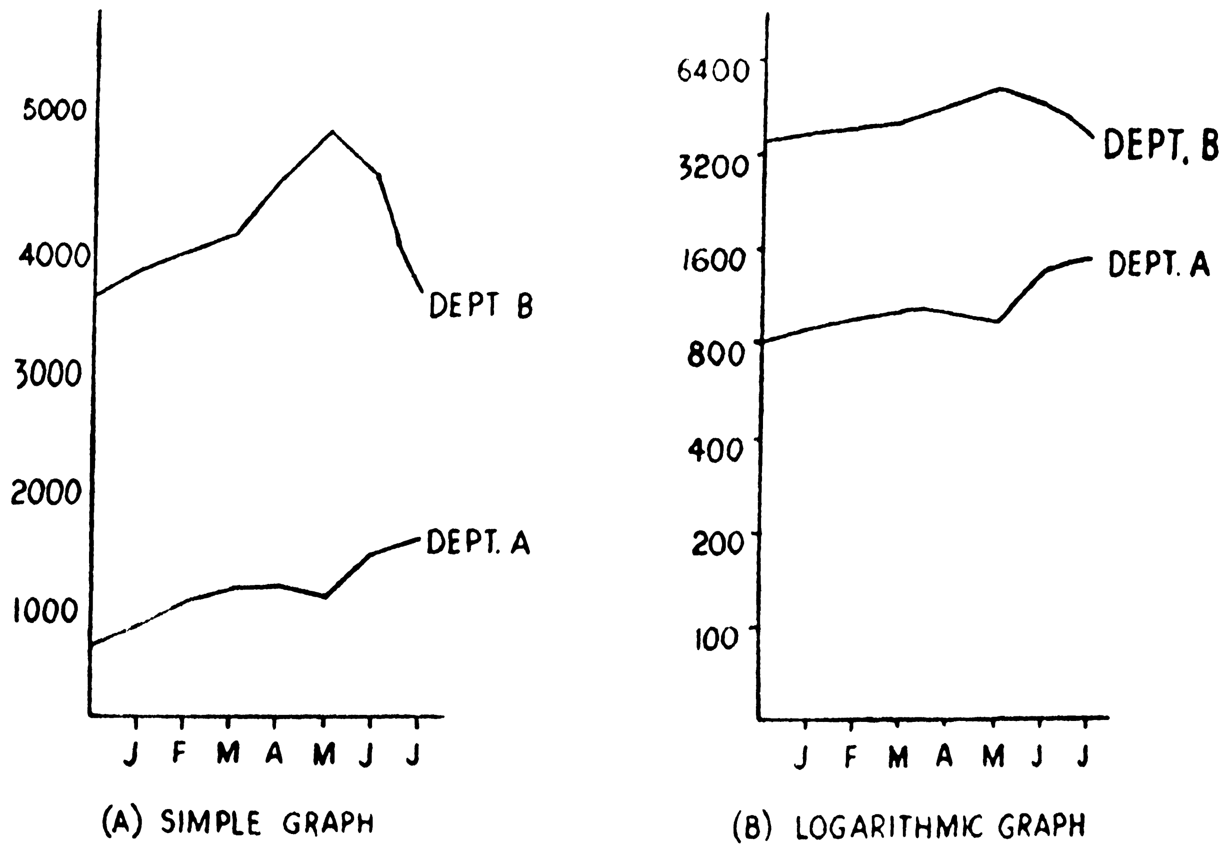


FIG. 95. COMPARISON OF TWO GRAPHS

in Fig. 94, when the similarity in the seasonal changes will be most marked.

In the graphs so far described the scales have all been on a simple arithmetic scale, where a change of 22,010 to 24,000 has resulted in just the same curve as the change of 10 to 2000. But the latter is obviously of greater significance because of its increased proportion, so that the scale arranged on a logarithmic basis is better to show the rate of change, since the results will be shown by curves indicating the percentage increase rather than the actual arithmetical increase. This scale is arranged by taking the first unit as, say, 100, then the next will be 200, the next 400, and the next 800, so that each step of the scale results in an amount double the previous. The effect will be as in Fig. 95 to show whether the items are increasing or decreasing at a constant rate.

A divergence graph has already been referred to for comparison

of several years' figures with the moving average (Fig. 91), but such graphs are also used for plotting the difference between related facts. Thus, the total amount of sales may be compared with the total production for the period and shown in a graph as in Fig. 96,

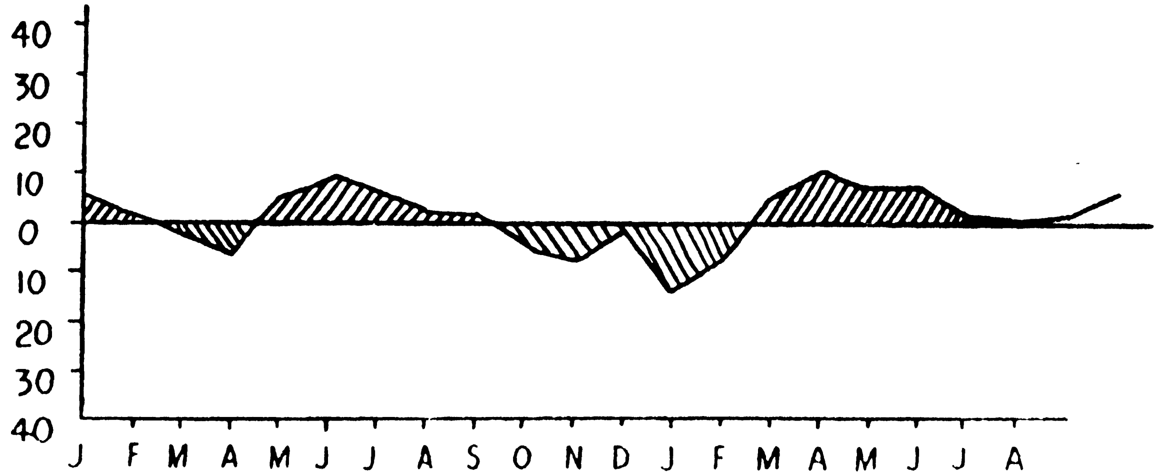


Fig. 96 Divergence Graph

with the lower part showing sales exceeding production shaded in red, while production exceeding sales is marked above the line shaded in green to emphasize the effect.

A system of charts was developed by Mr. H. L. Gantt for showing

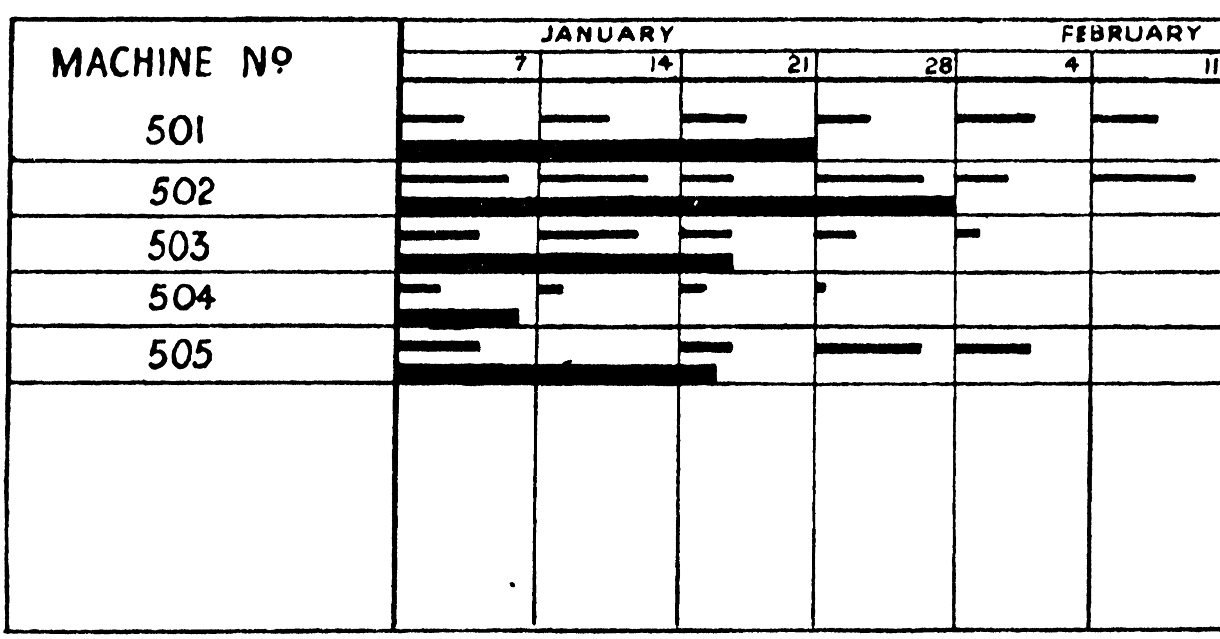


Fig. 97. Gantt Load Chart

the performance of work with regard to time, and are known as Gantt Charts. They are principally used for machine records, progress records and for idle time records. The basic principle is the comparison of actual performance against a schedule. This may be done in relation to the machines in the works and the work they

have on hand for aiding the progress manager, or it may be for scheduling actual production against the delivery dates of orders. One example only of a Gantt Chart can be given here, that of a Machine Load Chart, which shows the amount of work ahead of the machines (Fig. 97).

On this chart the thick lines show the total amount of work allocated to the machine if it were allowed to go forward with it,

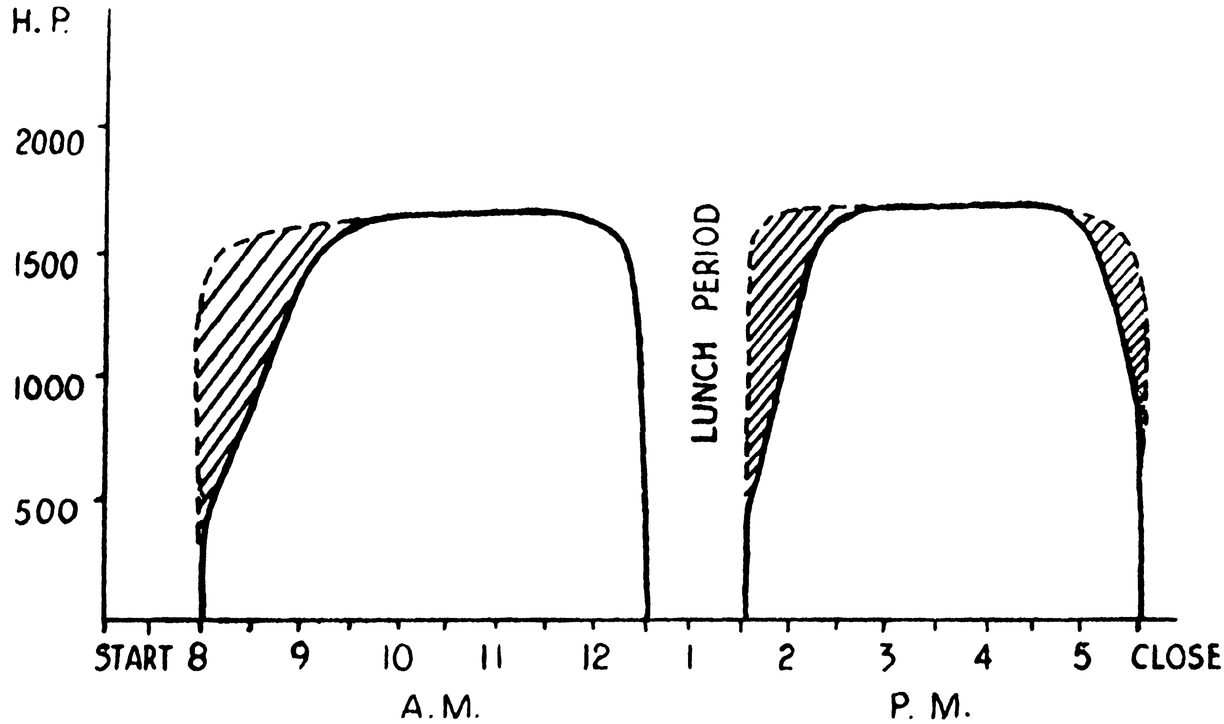


FIG. 98. POWER CONSUMPTION

while the thin line shows how that work has been allocated; thus Machine No. 502 has work to keep it engaged for four weeks, but one day of this week is free for any other work that may be necessary without interfering with the schedule for current orders, so that the information is clearly revealed for the Progress and Planning Departments.

Most of the more common forms of the charts used in business have now been described, together with many of the uses to which they may be put, though as a general rule it may be stated that almost any information, of whatever form it may take, if it varies at all in differing circumstances, may be made the subject of a chart of some form. A large manufacturing business in the north made a chart of the total consumption of power during the normal business day, and was surprised to see it as in Fig. 98.

The cause is obvious—the delay of operatives to get going at 8 a.m. and 1.30 p.m. when they start and the tendency to slack off

towards 5.30 p.m. This was immediately checked, and the saving resulting is indicated by the shaded portion of the graph. Labour turnover (i.e. number of men discharged) may be usefully compared with the labour costs of production and with the total amount of spoilage of material, and is often very informative. A sales graph may show the various lines handled and be compared with the costs of production, and with the costs of advertising. In the case of advertising the "lag" between advertising expense and the resultant sales coming in will be obvious when shown in graphical form.

One final word must be added. It is no use drawing up extensive and comprehensive graphs for a business unless the information which they give is fully utilized by the management, who must be taught to interpret them and act upon their guidance. If this is not done, then the charts are useless and the management are only groping in the dark.

APPENDIX

EXAMINATION QUESTIONS

THE following questions are taken from the examinations of the Institute of Cost and Works Accountants in the subject of Factory Organization, Equipment, and Production Methods.

1. GENERAL FACTORY ADMINISTRATION, ORGANIZATION, AND METHODS

1. Give your definitions of organization, management, policy, and system.

2. What are the duties of a rate fixer? Are the data which he obtains useful for any other purpose than piece price fixing?

3. Detail the exact routine through which an order passes from its receipt by the works to the dispatch of the goods. All subsidiary orders to be issued (if any), and the issue of instructions and information to be clearly indicated by chart.

4. What information should the works manager receive from the cost accountant and what action should result?

5. You have been requested to specify the number and types of machines necessary to provide for continuous output of a certain number of units. Explain exactly how you proceed to obtain this information.

6. What information from the costs would you pass on to the foreman in order to aid him in the control of his department?

7. What factors must be considered in the installation and working of a purchasing system?

8. Describe a complete system for planning and progress. Particular attention should be given to the allocation of the machines to be used and the method of recording progress.

9. Show by means of a chart the relation of the inspection department to all others of the factory.

10. Tabulate the departments to be provided in the organization of a factory, and state briefly the function of each.

11. What are the duties of a production manager? In a large works, what departments will be directly under his control?

12. In your own industry, or one selected, what information would the cost office supply to the works manager to assist him in the control of the factory? Show, with examples, the effect of such information on the working of the factory.

13. By what methods should the planning and progress departments control the time of completion of an order passing through the factory?

14. What information would you consider necessary to be given on a works order, which is the document authorizing the manufacture of certain goods? Would you recommend that a full copy be passed to every department of the works? Give reasons.

15. As it is essential that the progress department should be conversant with the position of all work in the factory, describe a system for obtaining the necessary information.

16. Outline the general principles of factory organization.

17. Assuming that you are taking a tour through a factory of your own industry. Compare in each department the relative importance of (*a*) labour; (*b*) equipment; (*c*) methods; and (*d*) materials.

18. Describe an ideal layout for a tool store, including a system for the issue of tools.

19. What do you understand by the term production control? Outline a system for its operation.

20. Show the position which a works manager holds in an organization, and briefly state what qualifications you would expect him to pass in order that he may properly fill the post.

21. Trace the evolution of the organization of a large modern factory from an old-fashioned workshop, taking as an illustration any industry with which you are familiar.

22. Outline the scope of the supervision, and state briefly the duties of each of the following: (*a*) general manager; (*b*) works manager; (*c*) departmental manager; (*d*) production manager; (*e*) superintendent; (*f*) foreman; and (*g*) charge hand.

23. Distinguish clearly between administration and management, giving examples from your own experience.

24. What qualifications would you consider most suitable in a candidate for the position of foreman?

25. In organizing a factory, what arrangements would you make to ensure that the works manager is advised of any divergence from the plan of production?

26. Outline a suitable scheme for the complete training of apprentices.

27. What psychological needs and desires must be met in order that industrial relations may be as harmonious as possible?

28. In addition to "knowledge of his job" what qualities or characteristics would you require in a man to be promoted to departmental manager?

29. In what way does labour turnover affect the efficiency of production? What steps should be taken to ensure that it is kept as low as possible?

30. A material control section is introduced into a factory to ensure that material is to hand when required and is of requisite quality and quantity.

What department do you consider should be responsible for it? Describe generally its relation to all other departments.

2. Factory Buildings

1. What factors influence the temperature to be maintained and the amount of heat required to maintain that temperature in a workshop or factory?

2. Taking examples from workshop and offices, explain the principles which govern their correct lighting, giving details as to how it should be arranged.

3. What do you understand by the heat conductivity of various materials, and how would you expect the materials from which a factory is built to effect the cost of heating?

4. Lighting for a factory must be both "Adequate" and "Suitable."

Describe under these headings the system you would recommend for your own or a selected industry.

5. Describe generally a method of ventilation for a factory to comply with the requirements of the Factories Act, 1937.

6. What are the various types of building construction available for factories? State which you consider preferable for any industry, giving reasons for your selection.

7. Describe with as much detail as possible an efficient method of protecting a factory from fire.

8. Discuss the influence on the total cost of the product of choice of the site for the factory.

9. How would you proceed to approximate the cost of heating a workshop? Any form of heating may be used for an example, but it must be assumed that a thermometer is the only instrument available.

10. What are the advantages and disadvantages of concrete buildings in comparison with brick?

11. What do you understand by heat insulation? What materials can be used for this purpose, and what application of the principle is useful in the factory?

12. What factors would influence the choice of a multi-story building for a manufacturing industry? Give a list of those for which such buildings are preferable or essential.

13. What six major factors of economical working govern the suitability of a site for the factory? Arrange these in the order of their relative importance, having regard to the industry with which you are best acquainted.

14. A works generates its own power. In certain departments large machines are installed requiring considerable power and run only at irregular intervals. How would such conditions be provided for, when laying out the power-house?

15. Explain how heat is transmitted from the furnace to the water in the boiler and what factors influence the rapidity of the transmission.

16. Describe as fully as possible how you would estimate the loss of heat from a building and thus calculate the cost of maintaining a particular temperature.

17. Tabulate and discuss the principal advantages and disadvantages of concrete factory buildings.

18. To what extent does the material from which a factory is built affect the cost of heating? Explain on general lines the method of determining the amount of heat required to maintain a suitable temperature in the factory.

3. Power, Machines, and Lay-out

1. Illustrate, with diagrams, how you would group machinery for (*a*) continuous processes; (*b*) production of varied products.

2. Compare the Lancashire and water tube types of boilers, both in construction and working.

3. Outline a complete system for dealing with the repair and maintenance of machinery.

4. Where would you look for inefficiency in the transmission of power by shafting and belts?

5. Describe, if possible, from your own experience an inefficient method of driving a machine on group. State how you would suggest that the drive should be improved.

6. A factory generates its power by means of steam boilers, engines, and electrical generators. Would you recommend the adoption of steam or electrical heating? Give fully the arguments in favour of your recommendation.

7. Compare fully the relative advantages of either (*a*) the reciprocating engine and turbine, or (*b*) the Lancashire boiler and water tube boiler.

8. Given the number and types of machines required in a new department, state just how you would proceed with the layout, mentioning as far as possible all the factors which will influence their position.

9. Describe fully a system for the proper repair and maintenance of the machinery in a factory.

10. Compare the advantages and disadvantages of power transmission in a factory by electrical or mechanical means; if you recommend a combination of both, state the circumstances.

11. Make a diagram showing as fully as possible how electric power is distributed through a factory.

12. Comparing mechanical and electrical transmission of power to a machine, state in each system the points at which loss would occur between the steam engine and the machine, giving the nature of the loss and, if possible, the methods by which it may be measured or estimated.

13. State the principles to be observed in order to obtain maximum efficiency when laying out belt drives for machinery.

14. Make a sketch showing the ideal layout of machines in a factory employed in the production of a commodity, preferably in your own industry, and give your reasons for the layout you adopt.

4. Materials, Stores, Transport, and Standardization

1. It is advisable to keep to a minimum the variety of shapes and sizes of materials in store. What steps can be taken to ensure this?

2. What do you understand by the following terms: maximum stock; minimum stock; ordering quantity; and what factors influence the settlement of each?

3. Explain fully how the issue of material is controlled.

4. In a small factory employing about 250 men making a variety of articles, material is issued from the stores on the sole authority of a bill of materials drawn up for each job. Do you consider the requisitions should be used? Give reasons for your answer.

5. Give a detailed description of any type of mechanical or gravity conveyor, and show how you would measure its advantages over a more primitive method of moving material.

6. In laying out a new factory, how would you estimate the amount of space to be allowed for the stores and what factors would influence their location?

7. What do you understand by "standardization" as applied to production? Do you consider its tendency is to aid or to limit progress? Give reasons.

8. Outline a system for controlling the issue of tools from the store, including means for ensuring that operators are not kept waiting unduly.

9. Describe a system of marking goods in stores to facilitate rapid location of any particular item. Illustrate your answer.

10. Describe the construction and operation of a Gantt Chart as applied to machine loading.

11. Describe a system for the control and working of the internal transport of a factory.

12. In a company operating several district works, would you recommend centralized or localized purchasing? Give your reasons for and against your recommendation.

13. In what way is the inspection department concerned with the purchase of raw material? Give an example with a full description of the procedure taken from any industry with which you are familiar.

14. Certain materials are of such nature that it is found impossible to issue exact quantities from store. How would you ensure that under such conditions any surplus is returned or otherwise accounted for? Give examples.

15. Do you recommend that material should be purchased on the direct requisitions of the storekeeper or should all requisitions be passed by the planning department? Give full reasons and illustrate.

16. Draw up a form for a "history card" recording progress on a job, covering all the information it should show and fill it with typical details relative to an industry with which you are familiar.

17. Describe a complete system for receiving goods into a factory, detailing how they are unloaded, handled, and each stage through which they must pass before being accepted into store. Illustrate your answer by reference to a particular industry.

18. Discuss generally the influence on the cost of a product of methods of moving material, and draw up a list of rules to be observed to promote the greatest efficiency.

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